

**A Community-based Approach to New Medium Integration
in South African Education:**

A Combination of ICT4D Process Approach and
Ethnographic Action Research Techniques

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**A Community-based Approach to New Medium Integration
in South African Education: A Combination of ICT4D Process
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Jakkaphan Tangkuampien, February 2013

Abstract

Our initial study indicates that successful integration of new communication medium into South African schools is not only challenging from the financial point of view, but also in terms of designing tools that fit within educational goals, as well as the training and support of relevant personnel in order to use the new medium effectively. Training and support effort, however, are often seen as top-down or outside-in approach that many teachers and past integration efforts have identified as being one of the contributing factors to integration failure. By looking at past integration efforts, as well as through our own initial study and in the field, we recognise similar results and challenges in efforts to introduce information and communication technologies into developing communities. Work done by Heeks et al. (Heeks & Molla, 2009) (Walton & Heeks, 2011) identified the Process approach as a contributing factor towards successful Information and communication technologies for development projects. We developed a novel approach to medium integration in education by combining the Process approach with Ethnographical Action Research techniques as well as taking into account recommendations made by past medium integration in education. To evaluate our approach we implemented the Process approach at an Ethnographical Action Research site with the researcher as one of the teachers with the objective of integrating the mobile medium into the school. Through our approach, the school was able to take the first steps in integrating the mobile medium and did so without participants feeling that that it was a top-down or outside-in effort – despite the researcher being seen eventually as the main driver of the project. Additionally, our approach was also able to overcome challenges associated with past integration. The Process approach encouragement of participants to chart their own course together with the passive presence of an expert in the community were identified as contributing factors to this positive outcome. Based on our experience, we conclude by producing a set of recommendations of how our combinational approach could be used by schools to integrate a new medium in future.

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Glossary

AMPS	All Media and Product Survey
AR	Action Research
BBM	BlackBerry Messenger
CASS	Continuous Assessment
CAT	Computer Applications Technology (An optional computer literacy course taught at high schools in South Africa)
EAR	Ethnographical Action Research
EIS	A system that was built at the participating school. The acronym stands for Electronic Information system.
FET	Further Education and Training
ICT	Information and Communication Technology
ICT4D	Information and Communication Technology for Development
ICTD	Information and Communication Technology and Development
IT	Information Technology
LAMP	A web server based on Linux, Apache, MySQL and PHP
LMS	Learning Management System
LO	Life Orientation (A compulsory subject taught at high schools in South Africa)
M-PESA	A mobile banking platform in Kenya
MDG	Millennium Development Goal
MXiT	a mobile chat service

NGO	Non-Governmental Organisation
NSC	National Senior Certificate
PDA	Personal Digital Assistant
PEAR	Process and Ethnographical Action Research – the name of our combination approach
PRN	Premium Rated Number
SIM	Subscriber Identity Module
SMS	Short Message Service
WCED	Western Cape Education Department

University of Cape Town

1

Introduction

1.1 Problem Overview

Our initial study indicates that successful integration of new communication medium into South African schools is not only challenging from the financial point of view but also in terms of designing tools that fit within educational goals, as well as the training and support of relevant personnel in order to use the new medium effectively. Training and support effort, however, are often seen as top-down or outside-in approach that many teachers and past integration efforts have identified as being one of the contributing factors to integration failure. This situation is not unique to South Africa, as many countries have tried and success has been varied. The level of resources allocated to the integration process by the school and governmental level did not result in a corresponding increase in success rate (Wilson-Strydom & Thomson, 2005).

By looking at the past integration efforts of new media as well as through our own initial study and on the field, we recognise similar results and challenges in efforts to introduce information and communication technologies (ICTs) into developing communities. Work done by Heeks et al. (Heeks & Molla, 2009) (Walton & Heeks, 2011) identified the Process approach as a contributing factor towards successful Information and communication technologies for development (ICT4D) projects.

We developed a novel approach to medium integration in education by combining the Process approach, used in the introduction of successful ICT projects into developing communities, with Ethnographical Action Research (EAR) techniques as well as taking into account recommendations made by past medium integration in education.

We proposed that our combination approach would bring about a successful integration of a new medium into a school. In order to investigate this, we applied our combination approach to integrate the mobile medium into the classroom.

1.2 Mobile Medium as an Integration Case Study

After the first democratic election in South Africa, the education system underwent an overhaul in order to address the inequality of the past. All of the race-based educational structures were unified under one Department of Education and a new curriculum for primary and secondary schooling (Grade R-12) was introduced.

This student-centric curriculum, initially known as *Curriculum 2005*, replaced the previous content-based curriculum where the teacher's objectives were to complete each content section. Instead, the new curriculum made the teachers responsible for ensuring that students understand and were able to apply concepts. This meant that the change for teachers was not just in content but also in how the teaching was to be done. One of the key recommendations was that teachers "*must find multiple ways of exposing learners to learning opportunities that will help them demonstrate their full potential in terms of knowledge, skills, values and attitudes.*" (South African Department of Education, 2002)

At the same time, mobile phone usage in South Africa experienced growth with a prediction that at least 75% of the projected population would have mobile phones by 2009. In fact, the 2010 All Media and Product Survey (AMPS) (Eighty20, 2010) indicated that in 2010 92% of South African households had access to at least one mobile phone and 63.6% of teenagers aged 15-19, personally owned a mobile phone.

The question that naturally arose was if, and how, the mobile medium could be integrated into the new curriculum. The new curriculum was phased in over time and, at the start of our study, the final phase for Grade 10-12 students was about to start. This timing represented an opportunity for the mobile medium to be integrated *with* the new curriculum instead of fitting it in afterwards as has been the case with many integration attempts. It is for this reason that the mobile medium was chosen as a suitable medium to test our combinational approach to integration.

1.2.1 Integration Outline

In order to form a viable combination approach, we employed a three-pronged approach. We looked at past efforts in integrating new media into education and also conducted a preliminary study by using Personal Digital Assistant (PDA) devices as a simulation for a mobile phone device and as a technology probe in a South African school. This was done in order to explore ideas and issues related to conducting further research. We also surveyed students and teachers across the high school demographic in order to gain insights into the usages and capabilities of mobile phones by the students and teachers. The survey results were also used to inform local participants of broader impressions of the general population of teachers and students in terms of mobile phone usages and capabilities; as well as possible content and services preferred by those groups.

Past new medium integration, as well as results from the technology probe and surveys indicated to us that ethnographical action research, with our researcher joining a number of schools by taking up teaching positions at the time of the new curriculum introduction, would be the best approach. The researcher as a teacher worked with other teachers and students to implement the new curriculum, while researching how best to integrate the mobile medium at the same time. This gave us unique insight into the situation.

The Process approach emerged as a reaction to the top-down blueprint approach and its inability to deal with complex scenarios (Bond & Hulme, 1999). Bond and Hulmes divided the Process approach into five components as follows - adapted from (Walton & Heeks, 2011):

1. **Beneficiary Participation:** Local people's knowledge is important for the successful introduction of the new system. With an intimate knowledge of the context, engaging local people is crucial for appropriate project planning and problem analysis, resource mobilisation, project monitoring and evaluation. Engagement in this change process can also encourage empowerment and knowledge transfer.

2. **Flexible, phased implementation:** Development should start small and adapt solutions based on feedback and experimentation.
3. **Learning from experience:** Projects should experiment and take risks on potential solutions, but focus on organisational learning as an outcome of failures and taking risks.
4. **Institutional support:** Local institutions should be utilized to establish local participation and to improve the capacities of local organisations.
5. **Programme Management:** Flexible, creative, professional, motivated and well-qualified leadership should be maintained. This will ensure retention of qualified staff and support learning and an adaptive environment where employees are able to contribute their full expertise.

Through reviews of past integration efforts, our own observations and interviews with teachers and students, we were able to identify challenges that needed to be overcome. Amongst these was the concern regarding negative response to top-down approach implemented in the past by schools and higher-up bodies. This was not directly addressed by the Process approach. Ethnographical studies have been used successfully in the field of ICT – most notably when it is combined with participatory Action Research (AR). Ethnographical studies and Action Research fits in well because both encourage the researcher to spend a large amount of time with members of the target group – the user and to derive many of end products from them (Tacchi, Slater, & Hearn, 2003). Ethnographic Action Research (EAR) approach can be used to bring about new activities while providing an insider approach instead of a top-down one.

1.3 Research Questions

We proposed that an approach combining the Process approach, past integration experience and EAR could bring about a successful integration of a new medium into a school. We refer to this combination approach as the PEAR approach. We

developed and applied the PEAR approach in order to answer these research questions:

1. Does this combinational PEAR approach result in a 'better' or more 'successful' integration of a medium into education?
2. Which part of the PEAR approach worked and can this approach be refined for use as a better or more successful way to integrate new technology into education?

1.3.1 Question 1 – Is it better and/or more successful?

Does this combinational PEAR approach result in a '*better*' or more '*successful*' integration of a medium into education?

With a new approach to integration, there is a natural question of whether this new approach is *successful* – does it result in a *better* integration of this new medium. *Successful* and *better* are relative terms. There have been a number of studies into past integration efforts and the reasons as to how they succeed and how they failed.

If our PEAR approach does not result in what can be considered to be *better* or more *successful* then it is useless to stakeholders. But what would these stakeholders considered *better* and *successful*. Their involvement is necessary in answering this question.

What would others in the past consider to be *better* and more *successful*? For that we need to look into past experiences of both ICT4D projects and medium integration efforts and evaluate what has been said by those who have tried to integrate new media in the past. We will also take into account actual participants' personal experience with past integration efforts in comparison with ours in order to answer the question whether our approach is considered to be better and more *successful* by these participants. This is in line with both the ICT4D Process approach and EAR.

1.3.2 Question 2 – which part worked?

Which part of the combinational PEAR approach worked and can this approach be refined for use as a better or more successful way to integrate new technology into education?

If the PEAR approach is successful, a critical question to ask is which part of the approach worked, and, if and how, could it be used to integrate other technologies and media into education with the same level of success. If a blueprint can be derived, our PEAR approach could potentially result in what stakeholders would consider to be *better* and more *successful* in future technology integration effort.

1.4 Chapter Outline

Chapter 2: Background to the Research Questions

In this chapter, we provide a brief overview of the new student-centric curriculum and how it affected teaching and learning in the classrooms. We also look at the phenomenal growth of the mobile phone usage in South Africa over the same period and motivate the suitability of the mobile medium as a test case for our combinational approach.

Chapter 3: Preliminary Investigations

In order to better understand the challenges of integrating technology into a South African school, we conducted a preliminary study with this issue. In this chapter, we present the result of this study. We also conducted a follow-up survey to find out more about the capabilities and usage of mobile phones by students across multiple schools from different demographics. We also reviewed an integration project, Khanya, which attempted to integrate ICT into state schools in a provincial-wide effort. The results of our preliminary study, survey and that of Khanya indicated clear parallel between integration challenges in education and ICT4D challenges. This led us to propose our combinational PEAR approach.

Chapter 4: Towards the Combinational PEAR Approach

In this chapter, we outline and motivate our combinational PEAR approach. We first look at the Process approach and ethnographical studies in detail. We then look at how they could be combined into an effective strategy in integrating the mobile medium into education – taking into account concerns that arise in an effort to arrive at a viable combined methodology. These concerns will be discussed in this chapter, culminating in the PEAR approach that was used in our study. We also break down our research questions further and end with a discussion on how we planned to evaluate our approach.

Chapter 5: Initial Plan and Determining Suitable Content for Delivery

In this chapter, we introduce the school that participated in our Study and the Planning Team. The Team consisted of local components within the school and the researcher acting as the Information Technology teacher. The Team produced an initial plan by firstly identifying suitable content for delivery over the mobile medium based partly on the Preliminary Study and the Survey (in which the school also took part). The types of content identified would be used to work with the teachers and students to integrate the mobile medium into education using the PEAR approach.

Chapter 6: Teachers' Iterations (T-Iterations)

In this chapter, we present how our PEAR approach was used to work with teachers to arrive at the design of the system created to deliver the chosen content in our integration effort. The initial specification of the backend system that will process and allow access to the content is also given in this chapter.

Chapter 7: Students' Iterations (S-Iterations)

In this chapter, we present how our PEAR approach was used to work with students to arrive at the design of the system created to deliver the chosen content in our integration effort. We also explore a number of delivery methods for our content with the involvement of students and teachers at the school.

Chapter 8: Answers to the Research Questions

In this chapter, we look back on our experiences in applying our PEAR approach as well as the surveys conducted by the school to evaluate the result of the integration. A number of reflection sessions were also held with the participants. We used these data collected to answer our research questions.

Chapter 9: Conclusions

In this chapter, we summarise the research findings, our contribution to the field as well as future research opportunities.

Appendices

Appendix A contains the detail and the results of the Preliminary Study. The questions and results of our Mobile Device Survey are presented in Appendix B. Appendix C contain the survey used by the school to evaluate the results of the integration effort. Appendix D contains a list and detail of activities in which the researcher was involved in during the project.

2

Background

Integration of new medium into education has existed as long as education itself. Many integration efforts have been categorised as successful while others have failed. In this chapter, we start off by presenting a review technology introduction in general and then a review of past attempts at integrating new media into education with particular focus on what constituted *success* for integration, as well as recommendations for how integration of each medium should have been done. We then have a look at the mobile medium and its suitability for integration into the South African education environment. Finally, we conclude by motivating that the mobile medium is a suitable test case for our combinational approach.

2.1 Technology Diffusion

There are several models of the process in which an innovation is diffused (adopted) and used in a particular community.

2.1.1 Rogers' Model for Technology Diffusion

Rogers' model of technology diffusion, first proposed in 1965, is the most well-known (Rogers, 2003). The four major elements in this model are:

- **Innovation:** The new innovation or technology that is to be adopted.
- **Communication Channel:** This is defined by Rogers as the process in which adopters "create and share information with one another in order to reach a mutual understanding". Rogers also included communication channels to outside sources in his model (*localite* channel for within the community and *cosmopolite* channels for communication with external sources). It is through these channels that the adoption spreads.

- **Time:** The time upon which the innovation takes to be adopted
- **Social System:** Rogers defined this as “a set of interrelated units engaged in joint problem solving to accomplish a common goal”. They are the different players and stakeholders with interest in the adoption of the innovation or technology.

These four factors play a part in the adoption of innovation in the specific community.

2.1.2 Innovation-Decision Process

In 1995, Rogers proposed the Innovation Decision process theory (Rogers, 2003) which states that innovation diffusion is a process that occurs over time in five distinct stages:

1. **Knowledge:** Individuals (potential adopters) learn about the existence of the innovation and seek out information about it.
2. **Persuasion:** Individuals develop an attitude (positive or negative) towards the innovation.
3. **Decision:** Individuals choose to adopt or reject the innovation
4. **Implementation:** An innovation is put into practice by individuals who decided to adopt the technology (adopters)
5. **Confirmation:** Adopters seek support for their decision.

2.1.3 Individual Innovativeness Theory

Rogers also classified members of the social system on their level of innovativeness. There are five different categories

1. **Innovator** (about 2.5% of the population): Individuals who were experimenting with new ideas.
2. **Early Adopters** (13.5% of the population): Rogers argue that early adopters are likely to be in leadership positions and as such can drive the adoption process forward.

3. **Early Majority** (34% of the population): These individuals adopt the technology just before the other half does and have a role to play in the process as they convince the late joiner to adopt the technology as well.
4. **Late Majority** (34% of the population): The individuals started off uncertain about the technology, but are later convinced to adopt it based on the number that has joined.
5. **Laggards** (The remaining 16%): These individuals may never adopt the technology for various reasons including lack of resources or holding on to traditional views etc.

Roger argued that these five categories of individuals exist in any given social system adopting a technology – in more or less this given proportion.

2.1.4 Perceived Attributes Theory

The Perceived Attributes Theory (Rogers, 2003) deals with how potential adopters judge an innovation based on their perception of these five attributes of the innovation:

1. **Trialability**: The innovation can be trailed before adoption – even if on a limited basis.
2. **Observability**: It also offers observable results.
3. **Relative advantage**: It has an advantage relative to other innovations or the current status quo in a similar field.
4. **Complexity**: It is not overly complex.
5. **Comparability**: It is comparable with existing technologies.

The theory states that an innovation will have an increasing rate of diffusion if potential adopters perceived all these attributes to be true for that innovation.

2.1.5 Instructional Technology Diffusion Theory

There have been many attempts to develop these innovation diffusion theories for the specific purpose of diffusing technology in education. In the field of instructional technology, Surry categorised these attempts into broad groups (Surry, 1997) as follows:

- **Macro-level Diffusion Theory:** The focus is on the reform of the educational institution and often used to adopt a wide range of innovative technologies and practices. Because the aim is for community-wide effect, the institution itself often drives such attempts.
- **Micro-level Diffusion Theory:** The focus is on the adoption of a specific innovation and increasing its utilisation rate within a specific community and not on the large scale, systemic change.

Surry (Surry, 1997) also discussed the driver of diffusion effort and grouped attempts based the following:

- **Developer-Based:** The developer or the architect of the innovation is seen as the force of change and a main driver of the diffusion effort. The focus here is on the product development. The developer would focus on making products superior to what is out, there with the belief that doing so will convince the potential adopters to take up the innovation. Surry argues that while this approach has created many pedagogically sound and technically advanced products, it does not seem to solve the product utilisation issues in the field of instructional technology. Technical superiority alone is not enough to drive diffusion.
- **Adopter-Based:** In these theories, the contributing factors for successful diffusion are the adopters and interpersonal aspects of innovation diffusion. The frequently cited example of this is the QWERTY and Dvorak keyboard example where users chose the less efficient QWERTY due to a variety of non-technical factors such as interpersonal and social ones (Burkman, 1987).

Developer-based and adopter-based theories start from different groups of the adopter population of Rogers' Individual Innovativeness theory and both have been used in macro- and micro-level diffusion effort. Surry (Surry, 1997) argued for a more adopter-based approach as one that is more likely to lead to a successful diffusion. However, in a review of a variety of educational technology-related studies that have been based on Rogers theory, Sahin (Sahin, 2006) found that in many of the studies, the combination of both developer-based and adopter-based approaches were needed for success; and that in some studies, products that fit in with Rogers' perceived attributes theory helped adopters to see the benefits of the

innovation, but in others adopter-based factors greatly affected the adoption rate and utilisation level.

2.2 Review of Past Medium Integration

In this section, we look specifically at past medium integration efforts. It should be noted that the term ‘*medium*’ is used here to mean the conduit between teachers and students. The use of the term does not indicate how the medium is used. The medium can facilitate teaching and learning in different ways and is often left up to the teachers to work out how to integrate it into their teaching.

2.2.1 Past Media

The Blackboard

Prior to the introduction of the blackboard¹, teachers talked to students and made occasional use of paper-based exercises. Paper exercise books were not reusable or teacher-friendly. There was no way for the teacher to communicate visual ideas to the students en-mass (Ergo in Demand, 2006). The blackboard represents the first formal medium that was able to carry more than just verbal or printed content from the teachers to the same class at the same time. Teachers were also able to easily adapt the content that was being shown to the class.

Some sources (Scottish Famous Firsts: James Pillans, 2008) (Ergo in Demand, 2006), have contributed the invention of the blackboard to James Pillans, a Scottish schoolmaster who invented it and chalk sticks for use in his geography class in 1801. In the decades that followed, the blackboard became an essential teaching aid in many schools across the United States as documented in the book ‘*The black board in the primary school*’ (Bumstead, 1841).

In the book, the author argued that the inventor of the chalkboard “*deserves to be ranked among the best contributors to learning and science, if not among the greatest benefactors of mankind*”. Michael Welsh in his video clip entitled ‘*A Vision of Students Today*’ (Wesch, 2007), quoted the same comment in presenting the chalkboard’s

¹ Also known as chalkboard.

contribution as being valuable even today. Others have also argued that it (and its variants) is still the most useful tool in the classroom today. The book put together ideas on how the chalkboards were being used – something we take for granted today. The chalkboard and its successor, the whiteboard are now considered tools of the trade for teachers (Bransford, 2000).

However, the blackboard did not get integrated into the classroom overnight. Even in 1841, Bumpstead lamented the fact there were schools that decided not to put in blackboards because they are “of no use” to the teachers. One of his stated objectives of writing the book was in fact to show the teachers how to make effective use of the medium.

Television

It was widely thought that the television’s predecessor, the moving picture, would bring about a revolution in education. Thomas Edison famously said that “*books will soon be obsolete in schools*” and that “*it is possible to teach every branch of human knowledge with the motion picture*” – as quoted by Reiser (Reiser, 1987). Needless to say, this did not happen quite in that way. However, the television still has contributions in the area of education, but is limited in its role in the classroom.

In the 1960 Tyler (Tyler, 1960) argued that direct teaching by television is “*by no means the whole of teaching. It is simply the presentation part of teaching – the telling and showing. It can help in motivating learners; it can expound ideas and concepts and develop them logically; it can present models to be emulated; it can raise questions and pose problems; and it can provide some drill. But it cannot study individual learners and their interests and needs; it cannot provide individual and group activities; it cannot appraise individual progress; it cannot counsel and advise boys and girls with special problems; it cannot provide laboratory experience; it can do little toward the development of creativity and inventiveness; and it cannot provide much practice in applying principles, gathering data, and handling group problems democratically.*” The author further pointed out that most of the learning activities take place under the guidance of the classroom teacher. Only exceptionally mature students can manage to study via the television medium alone.

It is therefore rather not surprising that failed efforts to integrate the television medium into education continued in more or less the same form. In 1975, education television failed to provide *quality* education to the mass of children in countries short of qualified teachers (Carnoy, 1975). The main reason given in the report for the failure was that teachers must still be trained in proper use of the medium in order to gain noticeable results. Students left on their own to view even quality video content, over the long term², do not perform better than those students taught using traditional methods.

Even in studies where teachers were actively involved, the use of the television medium was problematic. In 2000, a study conducted in South Africa on the usage of televised broadcast called '*Teletuks*', whose stated aim was to supplement teacher's lesson and not to replace teachers (Roodt & Conradie, 2003), found that the pace of the presentation was too fast and that teachers had no control over this aspect. They also found that in schools where teachers were not present during broadcast, attendance was low. Another problematic aspect was that the broadcasts did not coincide with the school curriculum. Even more recently, the South African Parliamentary Committee on Basic Education held a meeting to investigate the quality of education and the challenges thereof. They requested submissions for the use of television broadcast of lessons, catering for areas lacking quality teachers. (Parliamentary Monitoring Group, 2010). A number of submissions raised concerns with the timing of the broadcast on national television and that teachers were not able to fully utilise the medium since the programme content would not coincide with their lessons as different classes may be at different points in the syllabus.

Computers and Related Technologies

In 1964, a project at Stanford University used computers to assist in the teaching of initial reading and Mathematics (Atkinson, 1968). Over the decades that followed, two opposing views emerged concerning the role of computer technology to support learning, as outlined in by Bransford (Bransford, 2000). One view was the mere presence of technology would enhance learning while the opposing view is that any money spent on such technology and time spent by students using them is

² Although there is score increase in the first year of usage of educational television. The report suggested that this could be due to the novelty factor.

money and time wasted – a view shared by some teachers involved in our Preliminary Study (See Appendix A).

However, as Bransford pointed out, there have been several reviews done by different groups that concluded that computer technologies are useful in enhancing learning if used appropriately (Bransford, 2000). Bransford described five categories in which this can be done:

1. Bringing exciting curricula-based real-world problem into the classrooms;
2. Providing teachers with tools to help scaffold and enhance learning;
3. Giving more opportunities for feedback, reflection and revisions to both teachers and students;
4. Building local and global communities that include teachers, students, parents, school and others; and
5. Expanding the opportunities for teacher learning.

Further recommendations (Bransford, 2000) (Unesco, 2002) put teachers at the center of the drive to make appropriate and effective use of computer technology as a teaching medium.

In South Africa, the Department of Education³ indicated the desire for integration of ICT into the education environment (South African Government White Paper, 2004). The South African School Network (SchoolNet – SA) has been exploring ways in which this can be done. In a report by SchoolNet entitled ‘Understanding ICT integration in South African Classrooms’ (Wilson-Strydom & Thomson, 2005), it was concluded that although progress in the direction of ICT integration is being made in South African schools, in order to achieve the Department’s ICT policy goal, more attention needs to be paid to the pedagogical practices that seem to be key in ICT integration. In schools with successful ICT integration, teachers have played a major role in the process.

³ Recently renamed ‘The Department of Basic Education’ and is responsible for primary and secondary education.

2.2.2 Lessons Learnt from Past Integration Efforts

2.2.2.1 Meaning of Integration and what constitute success

Integration is a relatively new word. Schools in Bumpstead's day never sought to integrate the blackboard into education – although he mentioned that he would like to see the blackboard becoming “a luminous object in that school” (Bumstead, 1841). To him, this meant equipping the teachers with both the device and the ability to use it. The measure of how successful the integration of the blackboard now seems to be a moot point – with every classroom equipped with a variant. For the blackboard it seems that its success is held to be self-evident and that the fact that it is widely used means that its integration is successful.

In the early days of television integration, the success criteria were in relation to its premise of a delivery medium for quality education in areas lacking qualified teachers (Tyler, 1960). It was categorized as a failure because most students taught using this method performed worse than students taught traditionally (Carnoy, 1975). More recently, the integration effort in South Africa focused on delivery of content to supplement what is being taught in class (Parliamentary Monitoring Group, 2010). For computer integration, the criteria seem to also be based along the same vein – to facilitate and enhance existing teaching efforts.

Defining integration effort as the process in which teachers take up a medium to facilitate and enhance teaching in terms of content delivery leaves open what it means for such integration to be a success. The level of success of integration of the blackboard, television and computers were dependent on how the teachers were able to make use of each one. The success of a handful of teachers in an institution does not indicate a successful integration of the medium. The blackboard, television and computers have all enjoyed pockets of success. Integration success is, in any case, only meaningful when discussed in relation to an institution or at a larger level. To use Surry's classification (Surry, 1997) in the field of Instructional Technology, the main aim of these projects was to diffuse the technology at a macro-level – often with the educational institutions themselves driving such attempts.

2.2.2.2 Teachers' Involvements

In the past two centuries, many new teaching media have been introduced as has been outlined. The blackboard was invented and driven by teachers. It is now an integral part in any classroom. A century later, it was discovered that educational television's success is dependent on being integrated with current teaching programmes. It failed when it provided no feedback to the teacher. Teachers need to be able to see and interact with students in order to ensure a student's understanding. More recently, it was concluded that successes in using ICT as a medium of teaching required teachers to be more than just present but to be actively involved in the integration process. Surry also argued that technical superiority alone is not enough to drive diffusion. Teacher-based approaches were more successful than those driven by the educational institutions themselves.

2.2.2.3 Teachers' Skills

It seems that with past integration, the teachers were required to play an important role as a media user. The knowledge required to make use of the blackboard was (and still is) minimal and teachers were able to readily make use of the board (Bumstead, 1841). Television (Carnoy, 1975) and ICT (Wilson-Strydom & Thomson, 2005) have larger technical gaps that must be met by teachers before they can successfully make use of the media. Past integrations suggest that when teachers were confident that they have crossed this gap, they were able to effectively make use of the medium as part of their teaching. While recent work has shown that both schools and teachers realise that understanding of pedagogy and content management skills are as important as technical ICT skills (Chigona, Chigona, Kausa, & Kayongo, 2010), many teachers in South Africa still feel that they still lack capacity and support to achieve the goal of using ICT in the classroom effectively (Bladergroen, Chigona, Bytheway, Cox, Dumas, & van Zyl, 2012).

2.2.2.4 Financial Cost of Integration

The blackboard, television and computers all have limited initial success in pockets. The problem, though, is that successful institutional level integration remains out of the ordinary in these media. Reports on blackboard, television and computer

integration all point to financial cost as one of the main factors (the other being skill) preventing technology into the classroom. Acquiring technology at such high cost cannot be justified if institutional level success cannot be achieved.

2.3 The Mobile Medium and South African Education

Over the last decade, South African's mobile network growth was phenomenal making it one of a few countries with the highest mobile penetration rate. Cellular statistics at the start of the project (in 2006) provided by cellular network operators indicated that there were already more *active*⁴ subscribers than there are number of South Africans (Senne, 2006). Active subscriber numbers does not indicate the number of people with mobile phones but rather the number of active Subscriber Identity Module (SIM) cards in use. A more relevant set of statistics was provided by the 2004 AMPS Household Survey (Eighty20, 2004), which indicated that 41% of all South Africans own or have access to a mobile phone. Couple this with the actual growth rate of subscribers, which grew by more than 30% from 2005 to 2006 alone. Almost all of this growth was in the prepaid sector which the networks were linked to the lower income group (Senne, 2006). At the time, industry experts projected (Sikhakhane, 2006) that by 2013, a significant number of South Africans would own a mobile phone with at least 75% of the projected population having mobile phones by 2009. More recently, the 2010 AMPS Household Survey (Eighty20, 2010) indicated that 92% of South African households have access to at least one mobile phone and 63.6% of teenagers aged 15-19, personally owned a mobile phone.

The phenomenal growth of the mobile technology has made it enticing for it to be used in South African education. In the next chapter, we will present the reason for this in more detail, but first some background on the South African educational system.

2.3.1 Background to South African Education

In this section, we provide a brief overview of the South African education system, which has been undergoing major changes since the end of the Apartheid in 1994.

⁴ The definition of *Active* subscribers varies from network to network, but generally an active subscriber is one that makes a chargeable call/SMS within 3 to 6 months period.

We have a look at the road towards this new curriculum - *Curriculum 2005*, its subsequent revisions and their effects on the education system in today's post-Apartheid South Africa.

In South Africa, children attend formal schooling from the age of 5 starting at Grade R (Reception Year). School is compulsory up until Grade 9 (Age 14-15) with the last three years (Grade 10-12) optional. At the end of Grade 12, students sit a national examination. (South African Government Department of Communication and Information System, 2009).

Many primary schools in South Africa offer Grade 1 through to 7 as well as Grade R. There are however many nursery schools that offer pre-Grade R education as well as Grade R. Typical secondary schools in South Africa offer Grade 8 through to Grade 12 with some specialist schools focusing only on the non-compulsory years of Grade 10 through to 12.

The Department groups different grades into four phases as follows:

- Foundation Phase: Grade R – 3
- Intermediate Phase: Grade 4 – 6
- Senior Phase: Grade 7 - 9
- Further Education & Training (FET) Phase: Grade 10 – 12

Since 1994, the *National Senior Certificate* (NSC) is the new school leaving certificate.

Curriculum 2005

In post-apartheid South Africa, many factors necessitated the change towards a new educational system. The main factor driving the change was the need to create equal opportunities for quality education for all South African children. There were also many negative stances towards the previously fragmented and race-based education system that some felt could only have been corrected by a new curriculum, hence the development of *Curriculum 2005* in 1994 (South African Department of Education, 1996). This curriculum was seen as more than just a curriculum but a structural change in the educational system in South Africa (South

African Department of Education, 2000). This structural change was implemented in phases according to the following time frame:

Table 2.1: Phase-based Implementation Timeline

<i>Phase</i>	<i>First implemented</i>
Foundation	1997 (Grade 1)
Intermediate	2000 (Grade 4)
Senior	2003 (Grade 7)
FET	2006 (Grade 10)

This meant that a child starting Grade 1 in 1997 would end up in Grade 12 in 2008 having gone through all the years with the new curriculum.

This new curriculum has at its core non-educational objectives, which were important to a young democracy such as: unify a divided nation, provide national identity, be inclusive and offer educational opportunity for all (South African Department of Education, 1996). In addition to these noble objectives, Adendorff et al. (Adendorff, Mason, Modiba, Faragher, & Kunene, 2002): described the following educational characteristic of *Curriculum 2005*:

Curriculum Changes:

1. A focus on competence, skill, and 'being able to do' (moving away from a focus on the recall of content knowledge)
2. The integration of different areas of school knowledge (by arranging the curriculum into Learning Areas), and the integration of school knowledge with everyday life and the world of work

Pedagogy Changes:

3. A focus on the learner (moving away from a focus on subject content, with the teacher as the center of attention and control)

4. Learners themselves construct meaning, making sense of the world through active, collaborative learning.

In terms of curriculum changes, the new curriculum emphasized the shift from the traditional aims-and-objectives approach to outcomes-based education, resulting in the curriculum being specified in terms of learning outcomes that should be achieved by students at the end of each grade (Adendorff, Mason, Modiba, Faragher, & Kunene, 2002) (South African Department of Education, 2000).

At the start of our Study, the implementation of the new curriculum had reached the FET Phase and the Grade 10 class of 2006 was following the new Curriculum for the first time. By that stage the curriculum itself had already been revised once resulting in the Revised National Curriculum Statement (South African Department of Education, 2002). A review of curriculum implementation (South African Department of Education, 2000) conducted at the time reported on the lack of knowledge stipulation in *Curriculum 2005*. There were inadequate specifications of essential learning in the curriculum and too much focus on skills and background knowledge. The revision attempted to deal with this tension by introducing Assessment Standards and various forms of content frameworks, which would provide the content that teachers were required to teach.

Even with further clarification in content and assessment standards, the core educational characteristics of *Curriculum 2005* remained. In 2006, the NCS was to be implemented in the FET Phase. Prior to and during the implementation, the news regarding this effort was mixed. There were concerns with lack of teacher training (Seale, 2006) (Kgosana, 2006) and lack of resources such as textbooks (Mhlongo, 2006). Positive news mainly came from the South African Government with reports on the benefit of the new curriculum (Gadebe, 2005) and the implementation readiness (Nthite & Otto, 2005) (Attwell, 2006) including the issue of teacher training. Even though FET Phase teachers underwent training, some of them were unprepared for the changes.

Prior to the move to the new curriculum, recommendations on how teachers could adapt to these changes were available from three official sources:

- **Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System** (South African Department of Education, 2001) specified the ideals based on the Constitution of South Africa, for the new curriculum.
- **National Curriculum Statement** first published in 2003 (South African Department of Education, 2003), was based on the ideals presented in the Education White Paper 6 above.
- **Assessment Guidelines for Inclusion** (South African Department of Education, 2002) – although this document was not produced for the FET phase, the guidelines provided for the earlier phases' implementation of the new curriculum. The guidelines were in line with the overall objectives of the system and since they were also based on the experience on the ground, were also useful as a starting point for teachers in the FET phase.

The National Curriculum Statement (South African Department of Education, 2003) specified that the adoption of the new curriculum in the FET phase must be consistent with the ideals stated in Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System (South African Department of Education, 2001):

- All learners can learn given the necessary support and that teaching is learner paced and learner based.
- Conditions must be created for learners to succeed. There must be a shift from categorising/labeling learners according to disability towards addressing barriers experienced by individual learners. Provision should be based on the levels of support needed to address a range of barriers to learning.

Assessment Guidelines for Inclusion (South African Department of Education, 2002) document further clarified the above points by making teachers responsible for ensuring that these objectives are worked towards in their classrooms.

2.3.2 Use of Mobile Medium in South African Education

With chronic shortage of resources and textbook, the mobile medium seemed like a

natural choice for ensuring that learning content and other material are available to students. Our project was started just prior to the implementation of the new curriculum for the FET phase. It was also about this time that the teachers were being trained on how to work with the new curriculum. The recommendations for teachers from the Department of Education on how to implement and assess outcomes in the new Curriculum (South African Department of Education, 2002) included large references to the *student first* principle i.e. teachers must accommodate the needs of all students – allowing them to cover topics at their own pace according to their own abilities. The document went on to encapsulate what is expected of the teachers in the new Curriculum as follows:

“This means that educators must find multiple ways of exposing learners to learning opportunities that will help them demonstrate their full potential in terms of knowledge, skills, values and attitudes.”

With the increasing availability of mobile devices and phones, it would be beneficial to the students for the medium to be used as one of the ways to expose students to the learning opportunities mentioned above. However, it is not clear on how this could be done. There have been many studies conducted into deploying powerful mobile devices in learning environments (Danesh, Inkpen, Lau, Shu, & Booth, 2001) (Davis, 2002) (Moher, et al., 2003) with many conducted in the developing world (Brown, 2003) (Wang, Shen, Tong, Yang, & Han, 2005) (Kam, Kumar, Jain, Mathur, & Canny, 2009). Wang et al. in (Wang, Shen, Tong, Yang, & Han, 2005) described opportunities to use mobile devices in teaching, learning and course delivery in a Secondary School (K12) environment in China. Cheaper feature phones with basic services have been shown to have positive effects on education. Simple text messages can be used to stimulate students’ learning activities (Ho & Ho, 2011) – while game-based mobile learning tool for feature phones have had measurable educational effects on low-income schools in Peru (Frias-Martinez, Virseda, & Gomero, 2012).

As a result, the mobile medium is a good candidate for integration to a school environment and there have been many projects that have proven that it is a more than capable medium in which learning and teaching can take place, both as a standalone outside of the classroom and to supplement teaching. However, these

pockets of success need to be amplified into institutional (school-wide) level success or the mobile medium may run the risks of going the same way other media initially went. The blackboard took more than 40 years to achieve institutional level success while television and computers are still trying to get there.

2.4 Mobile Medium as a Test Case for Integration

There is no doubt that the mobile medium has a potential role to play in South African Education. The question is how it can be done with the limited resources available. Pockets of success already indicate that there are a number of viable applications that can make use of the medium, while past integration efforts indicate that real success of the medium usage only comes with institutional level integration – that of the whole school.

The mobile medium makes a suitable test case for our combination approach because there is a reasonable chance of successful integration. Not only do the pockets of success show us this, the situation on the ground also indicates that access to the mobile devices by students is higher than ever.

University of Cape Town

3

Preliminary Investigations

In order to better understand the challenges of integrating new medium into South African schools, we conducted a preliminary study into this issue. In this chapter, we present the result of this study (referred to in the thesis as Preliminary Study). We also conducted a survey to find out more about mobile phone usage by students across multiple schools of different demographics (referred to in the thesis as Mobile Device Survey).

We also review an integration project – Khanya. The project attempted to integrate ICT into state schools in a provincial-wide effort in the Western Cape region in South Africa. Many teachers at the school that took part in the Preliminary Study were also involved in the Khanya project.

We then motivate that the results of our Preliminary Study and that of Khanya indicated clear parallels between institutional integration challenges and ICT4D (Information and communication technologies for development) challenges. This then led us to propose a suitable method based on those that have been proven to be successful in introducing ICT into developing communities.

3.1 Preliminary Study

3.1.1 Objectives of the Preliminary Study

The aims of the Preliminary Study were:

- To help us to better understand the logistics and challenges of integrating a new medium into a school environment.

- To understand the roles, needs and capability of the different entities involved including teachers, students, parents and the school. This helped us work towards a suitable integration process.
- To bring about ideas on how the mobile medium can be integrated with the teaching and learning at school, and to discover an application that may be appropriate to field test our proposed approach.

In order to discover how to effectively integrate the use of the mobile medium into South African education, we conducted a study where we distributed PDAs. Note that the PDAs did not have any Internet connectivity support – this condition was necessary since the participating school had banned the use of mobile phones during class time. By that stage, they were one of many schools that had implemented this ban (Independent Online, 2006).

The main role of the PDAs however, was to act as technology probes. Technology probes are a particular type of probe that combine the social science goal of collecting information about the use and the users of the technology in a real world setting, the engineering goal of field-testing the technology and the design goal of inspiring users and designers to think of new kinds of technology to support their needs and desires (Hutchinson, et al., 2003).

3.1.2 Study Design

In the Preliminary Study, we distributed sixteen PDA devices to students and teachers to be used both during and after school hours. A summary of the study is provided below. More details of the study are provided in Appendix A.

School Profile

The school that took part in this study is a state, co-educational, secondary school with students from Grade 8 to Grade 12 (13-18 years old). The school is located in suburban Cape Town and has about 850 students and 38 teachers. This school was chosen because one of the teachers volunteered for the project and this avoided delays in having to apply for permission to conduct external research from the Department of Education (since it was now an internal research project). This school is located in a middle class suburb in an urban area. The school is also considered to

be in Quintile 5 by the Department of Education, which means that the school caters for the least poor (South African Department of Education, 2005). This may mean that the generality of our results would be limited but the results of the Mobile Device Survey gave us a better idea of how the data collected here is applicable to a wider school population.

Participants

A total of ten learners and six educators took part in the Study.

Students: Ten participants were drawn from the Grade 11⁵ Computer Studies classes. All were 16 to 17 years old. The gender split was nine males and one female; this is consistent with the profile of this class. They were selected by the teacher from this class, because they were more likely to be able learn to use the device within the short time-frame of the study.

Teachers: Six teachers agreed to take part in the studies. Four taught the learners taking part in the study, while two did not. They all taught Grade 11. There were no computing skill-based criteria for educator selection.

Equipment

Each participant was given an HP IPAQ 4190 (which is equipped with Bluetooth and Wi-Fi technologies) and accessories together with a Compact Disk of educational freeware and shareware. These were: a mathematical graph plotting program, a scientific calculator, a periodic table program that gives information on the different elements, an English dictionary, an English-Afrikaans⁶ dictionary, a note-taking program with simple shape drawing functionality and a voice recording program. The devices were distributed with the standard paper-based and electronic manuals provided by the manufacturer.

⁵ Equivalent to the 11th Grade in the United States and Form 4 in the United Kingdom. The students in Grade 11 are typically between 16 and 17 years old.

⁶ Afrikaans is one of 11 official languages in South Africa. Students are required to take another official language at a second language level in addition to their home language at first language level.

Data Capturing Methods

We were not able to observe participants directly in the classroom settings due to the reluctance of the school to allow for this. There was and still is still a large amount of negative perception involved in lesson observations as this is often equated with the past method of inspection. This was both the case at this specific school and with the teaching community as a whole. The idea of a school inspector was rejected by teachers and South African government as recently as 2012 (Nkosi, 2012). School management indicated that many of the teachers at the school still regard external observation as inspection and were not prepared to participate in this process. This was also reflected in a number of discussions with the potential participants at the school.

As a result, we proposed that teachers volunteer to participate in lesson observation. After a number of discussions with the teachers at the school, this was found to be unsuitable for the following reason:

- After a number of discussions with teachers (those who were interested in participating and those who were not), it was felt that those teachers who chose not to participate based on the negative association with classroom inspection would have been able to provide valuable feedback and that excluding them would create an unacceptable bias in the sample group. (Most who have negative association with classroom inspectors were opposed to technology integration, but we were not able to formally make this link based on the small number of interviews).
- At the time, the alternative idea of school inspection – Whole School Evaluation Policy (South African Department of Education, 2001) was in the process of being introduced at the school. The school insisted that a process that would involve classroom observation would require written permission from the Department of Education in the province. The Department, in response to our request, indicated that this application was not necessary to conduct an experiment. However, the school was still not prepared to give us permission without their consent. We were unable to overcome this deadlock situation.

Instead, the following indirect measuring methods based on questionnaires and interviews as recommended by various literatures (Babbie & Mouton, 2001) (Blomberg, Giacomi, Mosher, & Swenton-Wall, 1993) were used:

Paper-Based Questionnaire: This was used to investigate the following information for each participant:

- initial knowledge and impression of computing devices and technologies, including computers, mobile phones, PDAs and Internet.
- whether or not they had a mobile phone, its capabilities and how they use it. Students were also asked the conditions under which they were allowed to use their mobile phones.
- to evaluate educators' end-of-study thoughts.

Usage Diary: All participants received a usage diary, and were asked to complete it at the end of each class as well as at the end of each day. The diary prompts the participant on the level and purpose of device usage; as well as any software installed or removed each day.

Interviews with Students: In the middle of the study, we conducted semi-structured interviews with the participants. During the first part of interview, various issues were dealt with, ranging from technical difficulties, input method, usage, interaction with others and the usage diary. In the second part of the interview, participants were also free to express any issues concerning the study.

Online Questionnaire: When the learners returned the devices, they were asked to fill in a web-based questionnaire. The questionnaire was adaptive and was generated dynamically from the data collected from the first (paper-based) questionnaire and interview. Each participant was queried on their impression of the device and its usefulness (or lack thereof) in class. They were also asked for the perceived usage amount in each class.

Disruption Report Forms: A number of disruption report forms were made available to all Grade 11 educators. The educators were asked to fill in any significant disruption in their class that were caused by the introduction of the PDAs.

Interview with Educators: After the study has been concluded, six Grade 11 educators were interviewed. Four took part in the study, while two did not. They were asked about any disruption caused by the PDAs during and out of class and the steps, if any, they took to resolve the situation.

Loss of Equipment Report Forms: A report form was made available to students and educators to report the loss of the PDA. The form asked for a description of how the PDA was lost.

3.1.3 Summary of Relevant Results on Issues Related to Integration

More detailed results of this study are available in Appendix A. Only results related to integration are presented here. Other results are referred to in other chapters depending on their relevance.

Further interviews were conducted with the head of academics at the school that took part in the Preliminary Study to clarify issues raised by teachers. An additional interview to explore similar issues was also conducted with a principal of a private school on the results of the Preliminary Study. Appendix A also contains detail of the interviews.

Issues, related to integration, revealed in the Preliminary Study were as follows:

- Even in well-resourced school, ICT equipment was not seen to have high priority. Other priorities that came through from teachers and staff were textbooks, whiteboards, stationery supplies etc. Reliable electricity provision and affordable Internet connectivity are still issues in South Africa. Integration of new technology receives even lower priority.
- Schools did not have dedicated personnel and often had to hire an external expert at high cost in order to implement and support the technology.
- Schools did not have financial resources to justify the budget necessary for implementation and upkeep of equipment and/or system.
- Teachers, students and other users did not possess the necessary skills to make use of the technology effectively in teaching and learning.
- Technology integration projects were often pushed down from the top with little consultation with end-users. Teachers also raised concerns that

previous ICT integration efforts at the school had been ‘forced’ on them with no consultation prior and no support after implementation.

- Teachers, students and other users were busy with educational activities throughout the day and training (and other activities) must be timed accordingly.
- Technologies to be integrated were often designed for specific purposes that may be different to what the teachers would be using them for. Technology did not fit well within the educational context and had to be extensively modified. Other aforementioned factors make this difficult to achieve.

3.2 Mobile Device Survey

The Preliminary Study (Appendix A) indicated that we did not know enough about a typical student’s mobile phone and its capability. We also did not know much about the policy on such usage both at home and school. The Mobile Device Survey’s objective was to find out more about these issues. The Survey was conducted across multiple schools from different demographics. The full detail of the survey questions and results are in Appendix B.

Some of the objectives in the Mobile Device Survey questions came directly from the result of the Preliminary Study (Appendix A). These objectives were to discover:

- The types of information that may be suitable for the mobile medium including video, audio and text-based. Suggestions have been received from teachers and students in the Preliminary Study.
- The usage of mobile devices in education during class.
- The usage level of Bluetooth with students and teachers
- The usage level of Wi-Fi with students

We also included additional questions with the purpose of discovering more information about the current capability of mobile phones and the family policy around their usage at home. This information may prove useful in the later part of our studies when we want to deliver content to the student’s phones using the mobile medium.

3.2.1 School Profiles and Number

Four distinct profiles of schools (six schools in total) took part in the Survey. They were chosen to reflect the socio-economic landscape of South Africa:

Middle class co-educational state schools (Two): One of the two schools took part in Preliminary Study and in that school there were 856 students and 38 teachers. We received 35 responses from students and 7 from teachers. In the second school, there were 1189 students and 33 teachers. We received 52 responses from students and 8 from teachers.

Township co-educational state school (One): The school had 1635 learners and 53 teachers. We received 65 responses from students and 9 from teachers.

Non-uniform wearing co-educational private school (Two): The two schools involved belong to the same parent group and essentially have the same policies and structures. They are however located in different areas of Cape Town. In one school there were 238 learners and 25 teachers. We received 38 responses from learners and 18 responses from teachers. In the other schools, there were 452 students and 40 teachers. From this school, we received 42 responses from students and 11 responses from teachers.

Girls-only Private School: There were 225 students and 25 teachers in the high school section of this school. We received 25 responses from students and 11 from teachers.

Figure 3.1 shows the make-up of the participants in the two groups.

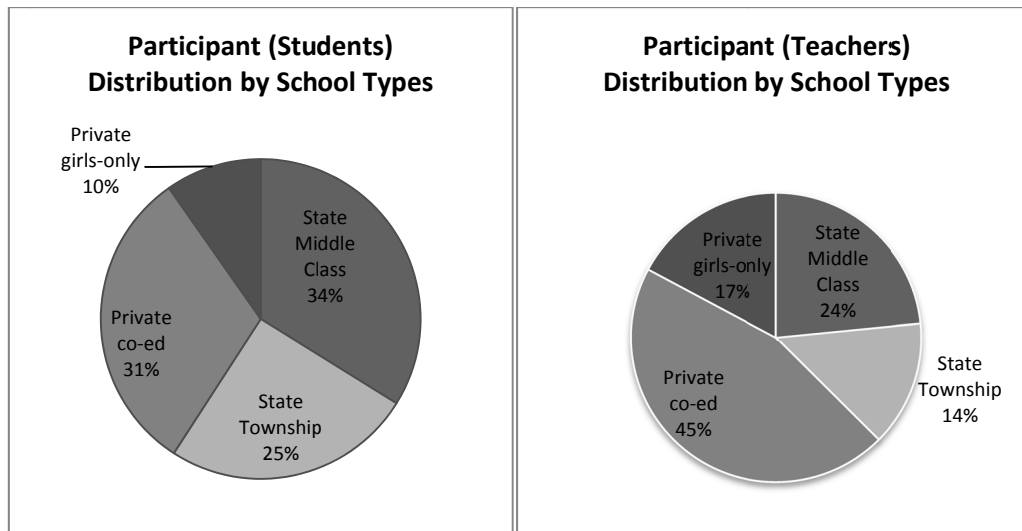


Figure 3.1: Survey Participants Distribute by School Type

3.2.2 Distribution Methods

The survey forms were distributed using two methods:

Printed form: Survey forms were printed and given to a teacher volunteer to distribute at his/her school. The staff survey forms were then left in the staffroom for teachers to complete. The survey forms were collected after four weeks. Volunteer teachers also asked other teachers to double check that every question has been answered.

Electronic form: A spreadsheet version of the survey were produced and given to CAT (Computer Application Technology) or Computer Literacy teachers who facilitated the data collection process. As part of an exercise for the subject, CAT/Computer Literacy students are required to survey students from the school and complete one spreadsheet per participant. They also consolidated their data into one spreadsheet. When students collected the data, participant's names were noted down to ensure that no student was surveyed twice. However, this information was removed during the consolidation process and was received by the researcher without any names. All of the data in the student survey were collected in this way. Each group had three weeks to collect their data and another to consolidate them. The overall student surveying process took over three months as different classes started their survey at different times.

3.2.3 Results of the Mobile Device Survey

The results of the survey were used during the application of our combinational approach. They are mentioned in the relevant chapters throughout the thesis. However, the full result is available in Appendix B.

3.3 Khanya Project: Issues and Challenges

The Khanya Project (Western Cape Department of Education (WCED), 2011) was an initiative of the WCED in 2001 to 'determine the contribution that technology could make towards addressing the increasing shortage of educator capacity in schools'. More specifically, the project aimed to provide human and material resources to enable schools to make use of appropriate and available technology to deliver curriculum to learners in the province.

In 2005, Khanya released a document on their proposed methodology for ICT implementation in schools (Scipio, 2005) based on their pilot studies and research into similar projects in other countries. The document identified the following challenges in carrying out their stated objectives in the province:

- Support infrastructures such as building, security, flooring, lighting and stable electricity supply were found to be lacking in some schools.
- The level of skill and training required for teachers will need to be evaluated and provided as there is a general lack of ICT skill.
- Buy-in and participation from schools, teachers, students, local community and other stakeholders must be sought. This can be done through the process of consultation to win their cooperation, support and ultimately accountability.
- The level of need for sufficient equipment compatible with the stated goal of curriculum delivery will need to be determined for each school.

In 2008, Khanya released a report (Khanya Project - WCED, 2008) outlining the “less successful” areas of the project as well as challenges experienced during the time that coincide with our Preliminary Study. In fact, some of the teachers who took part in our Preliminary Study also took part in the Khanya and specifically mention

their experience with Khanya during the interview (See Appendix A). The “less successful” areas and challenges included:

Training

- The cascade model of training did not work. This model suggested training of a few core teachers who are then able to train others. In practice, this model was found not to work and that more costly face-to-face training method worked best.
- Distance training was only successful with teachers who already possess a high degree of technical ability.
- Basic training in computer literacy did not work for teachers with no prior ICT training.

Equipment

- Refurbished computers were not cost effective and that Khanya recommends the use of the best equipment in even the poorest school in order to avoid equipment breakdown which could subsequently lead to disillusion with the technology being introduced.

Sustainability

There were four sustainability related challenges experienced by Khanya during this period:

- Financial sustainability relates to funding the running cost of facilities and their upkeep.
- Technical sustainability is concerned with the technical skill level the staff must have to maintain the facility.
- Operation sustainability refers to usage of the facilities in the future.
- Environment sustainability is concerned with the disposal of the hardware after they have become obsolete.

3.4 ICT4D

Incorporating ICT in developing communities has been proven to be different to doing the same for developed community. Technology and strategies for introducing technology that worked for developed communities do not necessarily work for the developing communities. Much research done in the fields of ICT4D, as well as in ICT and Development (ICTD), have concluded that the challenges experienced in the developing communities make the introduction of ICT for or into the community different to other areas. These challenges are outlined below.

3.4.1 ICT4D Challenges

It has been widely acknowledge that ICT has an important role to play to improving the lives of world's developing community. The United Nations Millennium Development Goal (MDG) number 8 - Target F (United Nations, 2000) encouraged many role players including governments, Non-Governmental Organisations (NGOs), donor countries, private sectors and the research community to "make available benefits of new technologies, especially information and communications". As a result, there have been numerous projects to incorporate ICT into various aspects including service delivery, educational, health and numerous other areas. Incorporating ICT into developing community has many challenges (Heeks & Molla, 2009) (Walton & Heeks, 2011) that can be summarised as follows:

Equipment & Infrastructure

- Lack of required infrastructure often posed a challenge for many ICT4D projects. Many of these projects have to deal with lack of equipment, electricity, Internet connectivity and other ICT essentials or budgets to provide for them. In many cases, lack of skills to introduce and subsequently maintain the required equipment and infrastructure is an additional challenge. Even in well-financed projects, there are often difficulties with maintenance of the equipment and infrastructures.

User of System

- Users' ICT literacy level compared to those in the developed world is relatively low. Some users have never made use of computers nor do they have access to the Internet. In many cases, the knowledge learnt in the developing world does not apply to users in the developing communities. Systems and interfaces that may have been proven to be user friendly and applicable to those in the developed world may not be found to be so in the developing world.
- Users do not see the purpose of ICT introduction. In many projects, the targeted users of the system do not see or understand the purpose of the new technologies that are being introduced. This can often lead to total failure of projects.

System and Introduction Process

- Lack of resources and user participation also extends to the design, implementation and the introduction process. In the developing world, targeted users may not be available to help in these phases. Often the result is that the system being introduced was not designed with the users in mind but had to be adopted, while not always being relevant to the local context. These phases may not have taken into account local conditions. Another example in addition to the design phase includes training sessions not created nor timed according to users' availability
- On the other side of the coin is the lack of qualified personnel for implementation, training, usage and support. The lack of user participation and longer-term availability of qualified personnel on the ground often means that the project had to be driven externally for a shorter period of time.

3.4.2 ICT4D Challenges and School-based Integration Challenges

On examination of challenges experienced in the developing communities, we see parallels with challenges in integrating new technology experienced in the school

that took part in the Preliminary Study. These challenges seem to be applicable even in well-resourced schools.

3.4.2.1 Lack of infrastructure such as ICT equipment, electricity, Internet Connectivity and high cost of implementation and maintenance

Table 3.1a: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
<p>Even in well-resourced school, ICT equipment is not a priority. Reliable electricity provision and affordable Internet connectivity are still issues in South Africa.</p> <p>Schools do not have financial resources to justify the budget necessary for implementation and upkeep of equipment and/or system</p>	<p>Lack of equipment and infrastructure was one of the many challenges that needed to be overcome by the Khanya project. In 2010, Khanya was still experiencing these issues in all schools they were involved in.</p>

3.4.2.2 High cost and/or lack of qualified personnel for implementation, training, usage and support

Table 3.1b: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
<p>Schools do not have dedicated personnel and often have to hire external expert at high cost in order to implement and support the technology.</p>	<p>Lack of qualified staff in the Western Cape schools was one of the many challenges that needed to be overcome by the Khanya project. Cheaper support methods (cascade or long distance) did not work well. More costly face-to-face method was found to be more effective.</p>

3.4.2.3 User's ICT Literacy level

Table 3.1c: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Teachers, students and other users do not possess the necessary skill to make use of the technology effectively.	Teachers lacked the skill necessary to make use of the technology with some finding basic literacy training (ICDL) to be challenging.

3.4.2.4 Users do not see the purpose of project

Table 3.1d: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Technology integration projects are often pushed down from the top with little consultation with end-users.	Khanya put participation and buying from all stakeholders as important, but difficult to achieve in practice.

3.4.2.5 Relevant activities such as training must be timed according to users' availability

Table 3.1e: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Teachers, students and other users are busy with educational activities throughout the day and training (and other activities) must be customised and timed accordingly.	Khanya's effort to fit in with the teachers' schedule meant that this was not a factor. Although it was noted that in some instances, there were insufficient training time outside of class time.

3.4.2.6 Application not user friendly in assisting teachers in the integration process.**System not relevant to the local context****Table 3.1f:** Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
<p>Technologies to be integrated were often designed for another purpose.</p> <p>Technology does not fit well within the educational context and has to be extensively modified. Other aforementioned factors make this difficult to achieve.</p>	<p>Khanya's hardware was chosen specifically for the purpose of integration. However, the general scope for integration often meant that teachers were overwhelmed by what should be done with the technology.</p> <p>Although Khanya attempted to provide a solution designed for an educational context, some teachers felt that the solution was too general for their own use.</p>

While parallels between challenges in developing community and poorly-resourced schools in a developing country may not be surprising, parallels between the former and well-resourced schools that are considered by some to rival schools in developed countries are unexpected. It is clear that in South Africa – at least schools in general, rich or poor – experienced common challenges as developing communities do when it comes to introducing new technologies into the area of education.

3.4.3 Examples of Successful ICT4D projects with Mobile Devices

There have been many successful ICT4D projects whose very aim is to overcome these challenges and to make differences in the lives of those living in the targeted communities. Amongst the successful ICT4D stories are that of the integration of the mobile medium into various developing communities.

Grameen Phone (Knight-John, 2008)

In a country with low mobile-phone penetration rate, the mobile network operator/financial services group Grameen successfully introduced a mobile phone deployment strategy which increased mobile penetration rate from less than 0.3% in 2002 to 45% in 2005 rural Bangladeshi. The strategy made use of a community-based approach which is the core of many ICT4D projects.

M-PESA (Huges & Lonie, 2007)

M-PESA is a mobile banking platform that has helped to bring banking services to the unbanked majority in Kenya. This project also made use of community-based approach resulted in more than 2000 M-PESA banking service delivery points in a country that had only 600 ATMs in 2007.

3.5 ICT4D and Medium Integration in Schools

The Grammen phone and M-PESA projects are only two examples where community-level success has been achieved in making use of mobile-based technologies. In the previous section, we were not aiming to provide an exhaustive listing of ICT4D projects but to rather motivate the idea that approaches used in these projects and many others in the field of ICT4D have successfully integrate new technology, particularly mobile technologies into developing communities.

Since the challenges to be overcome in introducing new technology into developing communities are parallel to those experienced in integrating new medium at school, it may be possible that methods used in successful ICT4D projects would lead to a more successful integration of new medium at a school.

In the next chapter we answer that question by combining the methodologies employed in successful ICT4D projects with recommendations made by past medium integration effort and user-centered design principles to arrive at our combinational PEAR approach to new medium integration at school. We will then formalise our research questions centering on the issue of whether such combination approach will indeed lead to a more successful integration of new

medium and if so which aspects of it (if not the whole approach) could be used for integrating new media in future.

University of Cape Town

4

Towards the Combinational PEAR Approach

In working towards *how to successfully integrate new medium into education*, we have explored

- Lessons learnt from past experience of integrating a new teaching medium into education and;
- Similarities between integrating new technology into developing communities and integrating new teaching medium into education – in terms of challenges face by both communities.

We proposed that methodologies deployed by the ICT4D research communities are very relevant to making integration of new medium into education successful. However, we are also mindful of past integration experience and that any integration approach, ICT4D ones include, must be done with careful consideration of these past lessons learnt. In this chapter, we outline and motivate the combination approach that we took.

4.1 Towards a Suitable Approach

4.1.1 Past Integrations and Educational Considerations

Past medium integration experience suggests that students using content over a medium without teachers is inefficient. Teachers should be involved to receive feedback and to help students if they experience difficulty. This is in line with the new curriculum which places the responsibility of ensuring that students achieve learning objectives squarely on the shoulders of the teachers. **Teachers must be**

actively involved in any integration effort and must be planned in with educational objectives.

Past medium integration also suggests that there is a technical gap involved with using and creating content for the medium that teachers must overcome before that medium can be used effectively. **Teachers must be trained sufficiently in making use of the medium.** The issue here is what would constitute sufficient training.

These two factors led us to conclude that just having teachers involved is very necessary, but this may not be enough. Integration effort seems to only be effective when teachers are trained on it. This is a Catch-22 situation: we need teachers to be trained to use the medium, before they can help to integrate it successfully; we cannot train them to use the medium we are trying to integrate into the new curriculum. Additionally, it took the teaching profession a long time to cross this gap for educational television. Teachers are still attempting to cross this gap now with ICT integration. It is fair to conclude that it would take a substantial time for teachers to cross the gap required for the mobile medium as well, if similar integration approaches were to be used.

4.1.2 ICT4D and the Process Approach

Evaluating ICT4D projects for success has many challenges, as it is often easier to see when one has failed. Heeks et al. have been working to identify factors contributing to success and failure in ICT4D projects (Heeks & Molla, 2009). This culminated in Heeks identifying the Process approach as a contributing factor towards a successful ICT4D project (Walton & Heeks, 2011). In that working paper, Heeks analysed successful ICT4D projects and found that they all have strong alignment with the Process approach components.

The Process approach emerged as a reaction to the top-down blueprint approach and its inability to deal with complex scenarios (Bond & Hulme, 1999). Bond and Hulmes divided the Process approach into five components as follows - adapted from (Walton & Heeks, 2011):

1. **Beneficiary Participation:** Local people's knowledge is important for the successful introduction or design of a new system. With an intimate

knowledge of the context, engaging local people is crucial for appropriate project planning and problem analysis, resource mobilisation, project monitoring and evaluation. Engagement in this change process can also encourage empowerment and knowledge transfer.

2. **Flexible, phased implementation:** Development should start small and adapt solutions based on feedback and experimentation.
3. **Learning from experience:** Projects should experiment and take risks on potential solutions, but focus on organisational learning as an outcome of failures and taking risks.
4. **Institutional support:** Local institutions should be utilised to establish local participation and to improve the capacities of local organisations.
5. **Programme Management:** Flexible, creative, professional, motivated and well-qualified leadership should be maintained. This will ensure retention of qualified staff and support learning and an adaptive environment where employees are able to contribute their full expertise.

Teachers, and subsequently, students are the main beneficiary of the integration process. Past integration experience, as well as our own Preliminary Study, recommended their active involvement. Heeks' work also pointed towards this importance with the above Process approach components relating to local knowledge and participations. With focus on the local knowledge, we proposed that a more effective and less time-consuming way to achieve teachers' active involvement is to make use ethnography. More specifically, a researcher with technical knowledge in the mobile medium would take up the role of a teacher in the classroom. With this set up, it was also possible for us to directly observe participants (students and teachers) in their natural environment – thus allowing us to learn from experience and achieve on the ground participation of teachers (as well as address the challenges with indirect data capturing methods experienced in the Preliminary Study).

We were also able to explore ways in which teachers and other stakeholders can be actively involved in the integration process. Active involvement does not just mean incorporation of a technology or tools that have been designed and developed externally. Concerns related to this were raised in other integration efforts as well as in our own studies. Teachers, students and other stakeholders must be actively

involved in the effort. To achieve this level of involvement we explored the use of an ethnographical study.

4.1.3 Ethnography and Ethnographical Studies

Ethnography is described by Babbie et al (Babbie & Mouton, 2001) as “*the data of cultural anthropology that is derived from the direct observation of behavior in a particular society.*” It has been used to study different cultures or in anthropology (Blomberg, Giacomi, Mosher, & Swenton-Wall, 1993).

Techniques used in ethnography have been deployed to study more than just cultural anthropological groups (Babbie & Mouton, 2001). In such ethnographical studies, the researcher attempts to understand the group, their actions and other group aspects, mostly through observation. However, such ethnographical studies also made use of other techniques including interviews and surveys. The level of involvement of the researcher varies and many texts have used different terms to describe them (Babbie & Mouton, 2001):

- **Researcher as complete observer** (also known as simple observation): the researcher remains an outside observer even though they are spending most of the time with the group. The understanding with the group members is that the researcher’s task is to observe and not act as a member of the group in any way.
- **Researcher as complete participant** (also known as participant or participatory observation): when the researcher is both an active member of the group and the researcher studying the group. The idea here is that the researcher is not just a passive observer in the natural setting but also attempts to put themselves in the shoes of the participants.
- **Combination of the two:** Researcher observes or acts as a member with the group at times. For example, participation as a member of the group can be done in order to understand the issue and come up with solution while passive observation is conducted during the evaluation of the solution.

4.1.4 Ethnographic Action Research (EAR)

Ethnographical studies have been used successfully in the field of ICT – most notably when it is combined with participatory Action Research (AR). For ICT integration, AR encourages involvement of the user in the design of the product (also known as participatory design), which is to be used as a result of the research. The nature of this process is cyclical with the results feeding in to the next iteration in order to hopefully result in a better and better product (Tacchi, Slater, & Hearn, 2003). Ethnographical studies and Action Research fit in well together because both encourage the researcher to spend a large amount of time with the members of the target group – the user and to derive many of end products from them.

Participant observation-based ethnographical studies are common in ICT drive efforts probably because the user base has been identified as an integral part of making things work.

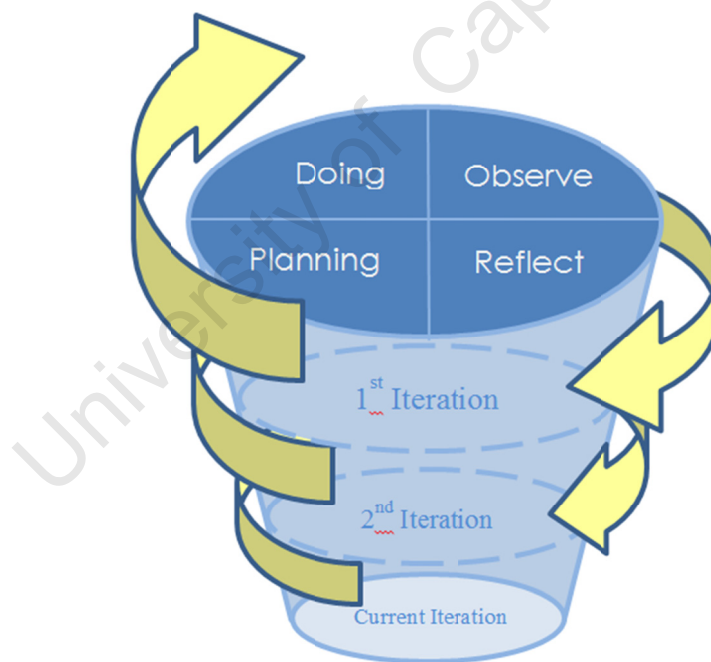


Figure 4.1: Summary of the Ethnographic Action Research Approach

Ethnographic Action Research (EAR) approach is used to bring about new activities. EAR involves an ongoing cycle of planning, doing, observation and reflection – each of which involves the use of both ethnographic research (with varying degree of researcher as observer and/or participant) and participatory techniques with actual users of the system.

Typically an EAR process starts off with the planning of the actions that need to be done to bring about the targeted activities or system within a community. During the action (doing) phase, observations of successes, failures, opportunities and challenges are made and recorded. These are then reflected upon and then used to plan the next iteration. The level of involvement of the research and the targeted community would depend on the ethnographical and participatory techniques used (Tacchi, Slater, & Hearn, 2003).

4.2 Combination Approach

Our approach to integrating mobile-phone based technology into a school environment was a combination of Heeks' recommended Process approach for ICT4D, past medium integration recommendations and Ethnographical Action Research methodology. Table 4.1 shows how these three supplement one another.

Table 4.1 - Combination of process-based approach, past medium integration recommendations and EAR.

Process-based Approach for ICT4D	Past Medium Integration Recommendations	Ethnographical Action Research
Beneficiary Participation	Teachers should be involved in many phases	Participatory techniques are used to involve the user of the systems in all four phases.
Learning from Experience	Feedback from teachers important	EAR's observation and reflection phases record failure, success, opportunities and challenges and use them to plan for next iteration.
Flexible Phased Implementation	Bottom up longer-term integration instead of top down quick approach	Involvement of the targetted users who help in deciding when and how to move on to the next phase.
Local Institutional Support	Less external involvement, more internal involvement	Unspecified. Local community involved with no or little visibility of the researcher
Programme Management	Should be driven by teachers	Unspecified. Local community involved with no or little visibility of the researcher.
No researcher role specified. Encourage more participation from local community.	Past failure indicated top-down method did not generally work	Researcher actively takes part and drives the design process with the target users.

4.2.1 Methodology Suitability and Concerns

Ethnographical Action Research allowed us to work towards our objectives of integrating a new medium into education as follows:

- It enabled us to get high involvement from teachers. Past ICT integrations raised concerns with teachers that the process did not take into account their work flow and what was happening on the ground. Our own Preliminary Study and the ICT4D Process approach findings also indicated that teachers' involvement is very important in the process. EAR enabled us to address this issue.
- EAR also enabled us to explore ways in which the technology can be integrated with the benefit of an expert in the field acting as a teacher, experiencing real issues and real concerns , while still able to bring their expertise in other areas to the table.
- An additional benefit of EAR is that participants often see the researcher as one of their own and this normally has the effect of reducing a perceived gap between outsider and insider (Babbie & Mouton, 2001) – thus allowing the researcher to be perceived as part of an internal entity to participants. This is important as past integration efforts and our own Preliminary Study have indicated that perception of top-down integration drive have affected past efforts negatively.

However, EAR also raised a number of concerns as follows:

4.2.1.1 Data Collection

Data collection in an ethnographic study can often affect the result or the data itself if participants are aware of the process (Babbie & Mouton, 2001). For example, non-intrusive but visible video recording equipment might cause the participant to react differently in an interview. A mere notebook can also cause this effect (Babbie & Mouton, 2001). Often data is collected solely based on the researcher's memory (Tacchi, Slater, & Hearn, 2003) but there are many techniques that may help in assisting accurate recall if done immediately after the interview or observation session (Babbie & Mouton, 2001) (Tacchi, Slater, & Hearn, 2003). Another helpful

data collection method is through the collection of artifacts (Tacchi, Slater, & Hearn, 2003) that resulted from the participants' normal workflow. In our research, we made use of similar techniques throughout various phases of integration, e.g. collecting notes written on a white board in the case of a teacher. We also collected data transparently by means of automatic logging. These efforts will be pointed out in the relevant chapters.

4.2.1.2 Ethical Issues

There are a number of issues relating to deploying EAR:

- **Multiple Roles:** Researcher has to play both the roles of researcher and participant - often playing both roles at the same time will cause the researcher to not do well in either (Babbie & Mouton, 2001). With an objective to internalize as much of the process as possible and to discover external factors, we review this issue at the end of the study to discover how much of the researcher's role has been to inject external input into the system and the level at which this was considered internal by the participants. We further address this issue in the next section (4.2.1.3 Conflicts between Ethnography and Participatory Design)
- **Informed Participants:** Should the participant be told of the study and in how much detail? This knowledge may cause the participant to act differently (Babbie & Mouton, 2001). Similar concerns also exist at the schools that we held studies. In our studies we followed the standard and the recommendations used by each schools which was to keep a management staff informed of any issues that may compromise a child's education. The participants' parents and guardian were also informed that a study was taking place but the specifics of the study were only notified if there was a potential negative effect. Teachers who participated knew of the effort to integrate the mobile medium and they were in the best position to decide whether or not the knowledge needs to be passed on to students. This can be seen as an advantage of internalizing the whole integration process.

4.2.1.3 Conflicts between Ethnography and Participatory Design

Ethnography and Action Research do not always fit well together. While ethnography attempts to understand the issues at hand by experiencing and or being a group member, researchers are often careful not to create the change in the group by their presence (Babbie & Mouton, 2001); one of AR's main goals is to affect change. These changes, once occurred, may cause the social dynamics within the group to change forever and the previous state of the group is possibly lost from the researcher. If the change is positive and intended, the researcher is in the right position to study the change. If the change is not as intended, it may be difficult, if not impossible, to then go back to the pre-affected state and redo the process again. Repeatability, after all, is not what is usually possible with ethnographic studies (Babbie & Mouton, 2001).

On the other hand, if the introduction of new technology brought about negative change – the school could remove the use of the new medium totally. Different ways to make use of the medium could still be explored if warranted. Historically, teachers have been involved in integration of new media over and over even if they have had bad experiences in the past. In fact, one of the issues that we needed to overcome in our own integration effort was the association of bad past integration efforts. In any case, in a school setting, past integration experience has informed us that pushing new technology externally or from the top has not worked and that changes should be driven from within. The Process approach suggested by Heeks also recommended a high level of involvement with beneficiaries and existing local institutions.

High involvement with teachers was necessary, but we also needed to be careful of feedback resulting from our own actions that may change the input from the user. Furthermore, it is entirely possible that a solution derived by a highly participatory study (Babbie & Mouton, 2001) as well as the Process approach (Heeks & Molla, 2009) may only be suitable for that group. However, reducing active participation of the researcher can guard against this.

4.2.2 EAR and Process Approach

On looking at Table 4.1, there are a number of places where EAR and the Process approach are complementary to each other. Both recommend a high level of beneficiary participation, learning from experience and a phased in approach. However, there are also a number of concerns in this combination approach:

4.2.2.1 Local institution support

EAR does not go as far as suggesting that the use of local institutions within the user grouping is necessary. However, in ICT4D case studies, there have been a number of cases that have drawn in participation of respected local institutions (which themselves consist of the targeted community and as such are still within the realm of EAR). This participation contributed to the success of some of these cases. Both the M-PESA and Grameen Phone cases make use of local service distributors that have mutually beneficial relationships with the communities while they are themselves part of the community (Walton & Heeks, 2011). In these successful cases, local institutions are groups within the community that are trusted by the community. In the cases of M-PESA and Grameen, they existed prior to the projects and already had the trust of the community. In EAR, there is a call for participation of all stake holders including “Community members” as well as “Community organisations” (Tacchi, Slater, & Hearn, 2003). Walton et al. (Walton & Heeks, 2011) contended that participation of respected local institutions is not just recommended but is essential in these successful ICT4D cases.

In a school, the direct beneficiaries of integration of new technology are teachers and students. The school management and parents are also beneficiaries of such integration though this may be indirect depending on the usage. Past integration effort and interviews conducted in our Preliminary Study indicated the level of involvement of teachers was not high enough. As with successful ICT4D projects, identification and participation of respected local institutions within the school may be the key to ensure that teachers and students feel that they are more involved. In some ICT4D projects this was only possible after some time was spent with and within the community.

4.2.2.2 Programme Management

EAR does not specify who should manage the entire process except to say that the community should participate. The Process approach undertook in successful ICT4D projects had a management team that maintained a flexible, creative, professional, motivated and well-qualified leadership (Walton & Heeks, 2011). We argue that in a well-functioning school, there already exists leadership that fits these criteria. Like many other factors in the Process approach, this may be considered to be interlinked with the others (Bond & Hulme, 1999) – suitable leadership of local institutions, that is trusted and respected, within the community were present in ICT4D projects that have strong Process approach elements.

4.2.2.3 Role of the Researcher

Process approach's localisation recommendation and the EAR's researcher's role of active participation in the design process can be in conflict depending on the level of participation of the researcher. Past integration experiences indicated that what is perceived to be top-down or outside-in effort is often indicated as a contributing factor to failure by participants. With this in mind, it seems that shifting as much of the integration effort to the local communities and reducing the active participation of the researcher in a way that is not perceived as a top-down or outside-in effort are key factors. This can be done in tandem but may not always be possible. The researcher could, of course, still participate within the group but only within the typical role of a teacher with specialisation in the subject he is teaching.

4.3 More detail on our Combination Approach

In the previous section, we combined EAR and the Process approach by looking at what they have in common and what distinguishes them from one another. In doing so, we have arrived at a starting point for our study. Both EAR and the Process approach have users' participation in them and as such any adaptation of methodology as we undertake the study is to be expected. In the rest of the thesis we will refer to our combinational approach as PEAR – a combination of approach based on the ICT4D Process approach and EAR methodologies. In this section, we describe the *starting* point of the PEAR approach.

4.3.1 EAR Detail

The researcher took up the role of a Grade 10-12 Information Technology (IT) teacher⁷ at the participating school. The studies took place over three years and the researcher assumed full teaching roles as the subject teacher at the school. The researcher started work as an IT teacher at the school one year before the start of the EAR study. At the start, any additional training that the school felt was necessary was also provided. These skills included those related to teaching and administration of classes.

4.3.1.1 Profile of the Participating School

The participating school is a private school offering tuition in Grade 10, 11 and 12 to children of both genders. According to the school, most parents are from the middle to higher-income brackets – although the school does have a bursary programme for previously disadvantaged and other deserving students. The school typically gives full scholarship to about ten students each year on average – while a varying number upwards of 30 receive partial scholarships for various reasons from financial difficulties to academic performance. During the course of our study, the school grew from 230 students to just over 300. The number of staff has also grown from 25 to 30 in the same period.

The core philosophy of the school is to allow students to express their individuality in an environment where teachers and students alike strive for the best results. This is reflected in the no uniform policy and a more relaxed atmosphere. In the experience of teachers at the school, this results in higher participation rate in class. The school is one of five in South Africa operating under the same brand and philosophy.

Teachers are also afforded more freedom to try out new ideas in the classroom and additional resources are provided if the teachers can motivate for it. The school has a long-term vision of incorporating new technology into teaching and encouraged teachers to do so through training and workshop provisions. However, the school, like most others, is under strain to keep under budget.

⁷ South African regulation only allows persons without teaching qualification who have degrees in relevant subject to teach at a high school level.

4.3.1.2 Information Given to Participating School

The school principal was informed of the research. He was also told that any questions could be raised or data collection process stopped at any point. However, from the ethical standpoint of a teacher, the researcher undertook to

- Complete the remaining part of an academic year should the research be terminated prior to completion.
- Remove any identifiable data that may allow any comments, personal data (such as marks and financial data) to be linked that to a student or family.

Teachers were informed of the study and that the data contained in devices, servers, observations, interviews and questionnaires would be used under the provision above. Parents and children also signed permission letters outlining the same. Both teachers and parents could choose to stop their participation at any time. Although such instances never occurred, the teachers or students who had withdrawn from the study would have been excluded from further studies.

4.3.1.3 Data Collection

A number of data collection methods were employed. They were chosen based on the recommendations by various reported studies (Babbie & Mouton, 2001) (Blomberg, Giacomi, Mosher, & Swenton-Wall, 1993) (Tacchi, Slater, & Hearn, 2003) as well as our experiences in the exploratory study (Study A). In all cases, academically sensitive information concerning specific students is excluded from the data gathering process. These methods were:

- **Informal Interviews:** These were unstructured and done with teachers and students during their free time. These types of interviews were valid (Legard, Keegan J, & Ward K, 2003) and useful, especially with learners who we have observed to provide minimal answers in formal interviews. They also allowed for much more probing follow-up questions to be asked. Teachers often sit in the staff room during free periods, break or before and after formal gatherings such as meetings, school and social functions and chats are often initiated in this setting. Chatting with students often occurred because they arrived at school early or had to wait at school to be fetched.

Sometimes topics to be discussed are raised by the researcher. Relevant data was then noted down as soon as possible after the conversation. To ensure that participants are in as natural an environment as possible, data recording is not done during the chat. We also extended this to interviews conducted by teachers with students without the presence of the researcher. This type of interview is not dissimilar to those conducted in ICT4D project by the chief of the Village or other local institutions.

- **Formal Surveys:** As part of the usual procedure at the participating school, teachers, students and parents filled in a questionnaire regularly on issues experienced at schools. We submitted questions relevant to our studies to the school to be incorporated into these surveys. These surveys are contained in Appendix C.
- **Observation/Participating Sessions:** Information was also gathered during Planning Team meetings, teacher meetings, parent-teacher meeting, student-teacher meetings and other meetings that occurred during normal duties of a teacher. These sessions are referred to internally as reflection sessions where participants are encouraged to voice any opinion as honestly as possible.
- **As class assignment:** Information was also gathered from students from class assignments in the subjects of English, Computer Application Technology and Information Technology. This is consistent with collection of artifacts (Tacchi, Slater, & Hearn, 2003) that resulted from the participants' normal workflow.

There were also other methods that were used as the study progressed. They were derived as part of the internalisation effort (see section **4.3.2.2 Identification of Other Local Institutions and the Internalisation**) and will be mentioned as they arise.

4.3.1.4 Role of the Researcher

In line with EAR methodology, the researcher acted and interacted with members of the school community in the same way as other teachers would. Furthermore, one of the research questions proposed an integration model that schools could make use of in future. Such school would likely not have a post-graduate computer scientist or an experienced programmer working in their ranks. This encourages the

use of local institutions in line with the Process approach. As such throughout the project, the researcher would:

- Be one of the teachers at the school including providing support and advice to various members during meetings, classes and other occasions in the same way that an IT teacher would.
- Not act, as far as possible, in a manner inconsistent with the role of an IT teacher. Specifically, this included providing advice that may be beyond that of a typical IT teacher such as design input to any integration process or advanced programming.
- Document any instances where advice and actions that could be judged to be beyond those an IT teacher we made or taken. These actions would then be evaluated as part of answering the second research question. These roles would then be critically examined to see if they can be substituted with other personnel and the cost associated with this in terms of both financial and effect on our integration model evaluated.

4.3.2 Process Approach Detail

Initially, we also took into account the Process approach components into our approach as outlined in this section (Beneficiary participation, Flexible, phased implementation, learning from experience, institutional support, programme management)

4.3.2.1 Management Team Involvement

There is a management team in place at all schools in South Africa. In typical South African schools (including the participating school), the management team consists of the principal and his/her deputies (usually responsible for academics, sport, cultural and other areas) as well as the Grade heads and subject heads. The management team has a hierarchical structure that includes all teachers. Although involvement from the top is necessary and their management skills valuable, we had to be careful to not present this as a top-down solution. To counter for this, the use of the Planning Team that worked independently of the management team was employed. (More about the Planning Team will be discussed in the next chapter.)

The Planning Team also strived to include student-based local groupings such as the SRC (Students Representative Council) and classes (e.g. The Grade 10 IT class or the Grade 11 Design class). The Planning Team also made a point of including non-management team staff members in all group-based activities (planning, doing, observing, reflecting etc.).

Heeks et al. suggested in (Heeks & Molla, 2009) that the questions that should be asked of the leadership are “How can they lead better?” and “How does each one’s perspective differ from others”. These questions were asked of all those of in leadership position. With respect to the second question, it is important that those representing different interests and perspectives are present in the leadership group.

4.3.2.2 Identification of Other Local Institutions and the Internalisation

Although the management team encompasses all teachers, it is still a top down structure. There is therefore a need for the Planning Team to identify other local institutions within the school that are not perceived as top down as well as one that involves other stakeholders such as students. In a Process approach, local institutions are used to establish local participation. In every action that is proposed (as part of EAR), we were always on a look out for local institutions (group of people within the community that will be able to establish local participation) – we referred to this as an internalisation effort – can internal structures, groups and people within the school be used to achieved that action. We needed to identify the role that each can play and how they can work together (Heeks & Molla, 2009). Internalization effort needs to take place in all phases – planning, doing, observing and reflection.

- **Planning:** Members of the Planning Team, participating teachers and students were involved in each step of the planning – from launch dates to evaluation sessions, such as surveys and reflection sessions.
- **Doing:** Whenever an action needs to be done, we first look inside the organisation for expertise within the community before looking externally. This included designers and programmers.

- **Observing:** We made use of internal observers for this as well. For example, students were already observing their teachers during the lesson. They could tell us if something is working or not. We also collected data from every day things that teachers and students were already doing – writing on whiteboards, notebooks and all the forms in use.
- **Reflection:** Feedback is important for both EAR and the Process approach. The school conducts regular anonymous survey with teachers and students and we were able to include our questions in those. We also held regular reflection sessions with teachers and students in order to plot the way forward.

Our contingency plan for cases where it was not possible to find local participation – we would first consider building up capability from within the organisation. This would be done via training, carried out internally if such capacity existed. If internal training capacity was not present, we would approach the parent body to seek that capacity. Parents are part of the school community – even though they may not be direct beneficiaries in most cases.

4.3.2.3 Flexible, phased implementation and learning from experience

We intended to start off the implementation of a component in a small internal group with teachers and/or students. We aimed to take advantage of the hierarchical structures already present at the school to identify, work with, phase in and test each component of the system with increasingly bigger groups. For example, teachers are already grouped into subject departments and grades. As such, we started working with the Mathematics department, but only with those who taught Grade 10s. We went on to the bigger group by including all Mathematics teachers. The bigger group already consisted of some teachers who knew the system well – making the move to the bigger group easier.

Students were also similarly grouped. We could start off with one Grade 10 Mathematics class, then all Grade 10 Mathematics classes and then eventually all of the Grade 10 students.

In each phase we monitored for emergent ideas, behavior and findings that would take the process forward (Heeks & Molla, 2009) – these may not be apparent unless

everyone was on the lookout for them. We also monitored for positive and negative findings and to learn from them – turning them into action for the next phase. Although we set a timeframe for each phase, one of the flexibilities we put in place was the ability to stop that phase at the acknowledgement of failure or to extend it if necessary.

4.4 Research Questions and Evaluation

As we worked out and implemented our PEAR approach, the following research questions needed to be answered.

4.4.1 Question 1 – Is it better and/or more successful?

Does this combinational PEAR approach result in a ‘better’ or more ‘successful’ integration of a medium into education?

Having proposed a combination approach to integration, there was a natural question of whether this new approach would be ‘successful’ – would it result in a ‘better’ integration of this new medium. ‘Successful’ and ‘better’ are relative terms. We intended to answer this question in two ways.

Firstly, consistent with both EAR and the Process approach, we asked the users and participants themselves to evaluate the integration process and to reflect comparatively to their past experience – if they consider this integration ‘better’ and ‘more successful’.

Secondly, since we have:

- based our approach on the components that has been identified to contribute to success in ICT4D projects and;
- identified common threads (Table 3.1 in Chapter 3) between ICT4D challenges and integration challenges experienced by schools in our Preliminary Study (relatively well-resourced) as well as those in the Khanya projects (state-schools from the least resourceful to the most);

we would look back at those challenges presented in Table 3.1 for both ICT4D and past integration experience and evaluate our own experience and results based on those identified as common threads. We would analyse the data collected in order to assess how much each of the challenges identified has been overcome.

4.4.2 Question 2 – which part worked?

Which part of the combinational PEAR approach worked and can this approach be refined for use as a better or more successful way to integrate new technology into education?

The second research question involved the combinational process itself. It might have turned out that only parts of the Process approach itself worked in combination with EAR. Knowing this may lead us to a blueprint of a better or more successful way to integrate new technology into education.

We intend to do by evaluating each of the contributing factors for successful ICT4D projects as identified by the Process approach to assess:

- the influence each had on the results and the integration process itself - positively or negatively.
- the influence the researcher has on the results and the integration process itself - positively or negatively – concluding in a list of critical skills used that may not be present in a typical school.

4.5 Summary and the Way Forward

In this chapter, we motivated that complementary nature of EAR and the Process approach elements present in many ICT4D projects. The main (common) recommendation of both approaches is the high participation of the community. While EAR gives us the structure upon which to investigate the integration of a new medium (in our case the mobile medium) into education; the Process approach will give us the ability to ensure that this integration is successful at an institutional level.

In addition to the structure, EAR would bring into focus the participation of the researcher as one of the community members, allowing him to get the feel of the challenges as experienced by the community and to gain trust and respect of the community. On the other hand, the Process approach would bring into focus the importance of existing internal institutions which have perhaps a more important role to play than the individual beneficiaries themselves (Bond & Hulme, 1999).

In working towards *How to successfully integrate new medium into education at an institutional level*, we proposed that the answers lie in a combination approach of using EAR and the Process approach that has been deployed in many successful ICT4D projects aimed at institutional level in developing countries. We refer to this combination approach as the PEAR approach. We also motivated the suitability of the mobile medium to test our combination approach. However, the specific aspect that will be integrated will need to be determined and carried out by the teachers and students at the EAR site. In order to give this community some ground work on which to decide, we looked at the Mobile Device Survey (which the school also took part), to discover:

- the capabilities of the mobile devices used by the students and teachers,
- their usage of the devices;
- family and school policies around using the devices as well as;
- Internet access from the devices and from home.

The survey questions were derived from the result of the Preliminary Study as well as by consultation with teachers and students at the various schools (including the EAR site). It was conducted at the EAR site as well as five other schools with varied profiles. The results of the Survey relevant to the planning phase will be discussed in the next chapter but the full result is available in Appendix B.

Our combinational PEAR approach is summarised in Figure 4.2.

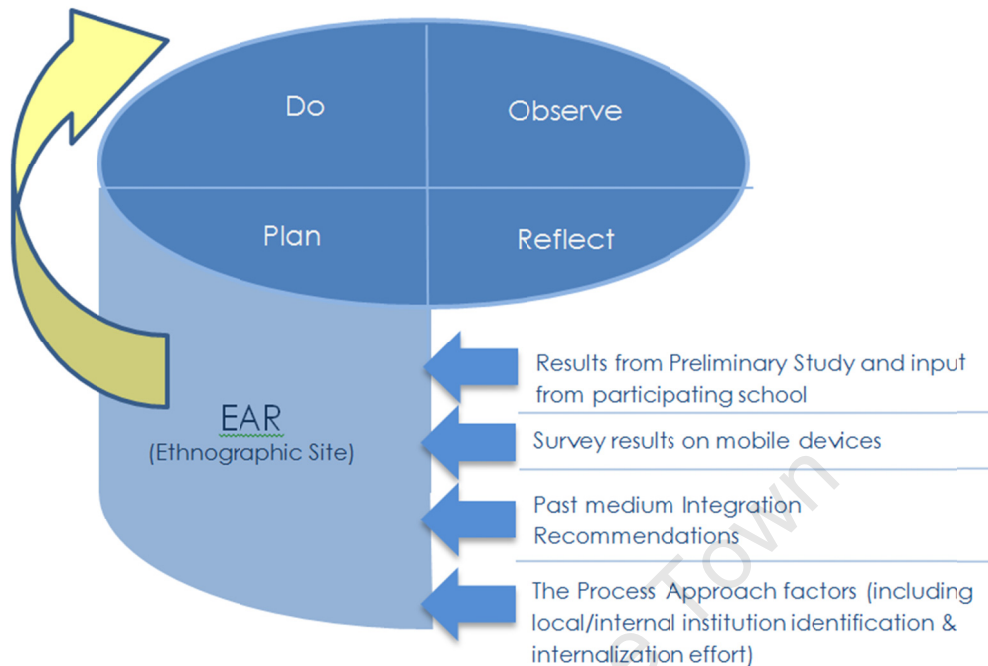


Figure 4.2: Summary of our Combinational PEAR Approach

Amongst the actions needed during the planning phase are:

- An aspect of the mobile medium that will be useful for integration at institutional level. Participants in the EAR site will decide on the content that will be delivered over the medium.
- Identification of additional management structures to the Planning Team that will be suitable for the subsequent phases and iterations. This included identification of local institutions and individuals that can take up key roles in our effort to internalise actions required in subsequent phases and iteration.

These were done while taking into account:

- **The result of the Preliminary Study and participants at the ER Site:** Teachers and students have provided some feedback on both the potential

usage of the mobile medium as well as their concerns and experience with past integration effort.

- **Results of the Mobile Device Survey.** The result of the survey is discussed in the next chapter, but the full survey is contained in Appendix B.
- **Past medium integration:** There have been various recommendations that resulted from past integration effort as outlined in chapters 2 and 3.
- **The Process Approach and EAR techniques:** We also take into account the five aspects of the Process approach and EAR techniques.

University of Cape Town

5

Initial Plan and Determining Suitable Content for Delivery

We start off this chapter by presenting an overview of the actions that must be done prior to the application of the combinational PEAR approach. This includes putting in a place all of the components necessary for the Process approach from local institution to management structures at the participating school. The relevant locally-based personnel as well as the researcher form part of the planning group that will initiate the combinational PEAR approach to integrating the mobile medium.

The aspect of the mobile medium that will be the starting point of the PEAR approach needs to also be decided upon. The Planning Team took into account, amongst other data, the results of the Preliminary Study and the Mobile Phone Survey in determining the content that will be delivered over the mobile medium.

5.1 Integration Plan

Amongst the actions that need to be during the planning phase are:

- In keeping with the Process approach's usage of local institutions – we needed to identify an appropriate institutions and individuals at the school to take up key roles initially in our effort to internalise actions required in subsequent phases and iteration. More local personnel can be canvassed as the need arises.
- We also needed to identify an aspect of the mobile medium that will be useful for integration at institutional level. This aspect should be chosen to include and benefit as many people in the school as possible. This will give

us the best possible chance of maximising the use of local participants. This aspect will be a starting point that is reasonably small to build on.

5.1.1 The Planning Team

The Planning Team did the initial planning for the study. It should be noted that the Planning Team is also involved in the planning of other IT related activities and was not specifically set up for this project. The Team met at least monthly and also as required. The Team consists of personnel within the school itself and usually consisted of:

- Principal and/or deputy principal
- Teacher in charge of staff training
- Teacher in charge of administrative matters
- IT teacher (the researcher) – also acts as advisor in the Planning Team (but only when asked directly to do so)
- Other teachers also volunteered to be part of the group. This changes from year to year and typically will include at least one Grade Head and the Computer Application Technology teacher.

The deputy principal also had weekly meetings with departmental heads who were responsible for canvassing feedback from his or her group not only in terms of our project but also for other purposes as well. Grade heads also met regularly and many issues were also discussed there. Each student was also allocated a mentor - a teacher who also taught Life Orientation (LO) to the student. Mentors were allocated students from the same grade and regular meetings were held between mentors and the grade head. Students also met up with their mentors at least twice a month.

These structures enabled input to be canvassed regularly from everyone in the school if required.

5.1.2 Mobile Medium Brainstorming Meeting

At the start, the Planning Team held a brainstorming meeting (Appendix D: Activity Reference⁸ #STF01, #MTM01) on medium integration where the following took place:

- Presentation by the Researcher (in his role as IT advisor on the committee).
- Brain storming and discussion session on the issues presented
- A plan of action towards integration of the mobile medium

The presentation included the following items:

- Motivation for the use of the mobile medium. This information is derived from information presented in Chapter 2 as well as information from the Mobile Device Survey (see Appendix B) and followed-up interviews conducted in the Preliminary Study (see Chapter 3 and Appendix A)
- Motivation for the involvement of locally available resources (existing computers, network and servers) and personnel (teachers, students, classes, assignments etc.) in the integration effort. This is, effectively, the use of the local institutions and resources encouraged by Process approach without calling it such. The main motivation for this was cost saving, as it would mean that the school could start with the effort without any cost.
- Motivation for a multiple phases of integration. This is in line with both EAR and the Process approach. The main motivation for this was to fit in with the Team's meeting time frame of once a month. The Team also conducted ad-hoc meeting after some staff meetings if necessary.
- Issues experienced in past integration efforts (also derived from information presented in Chapter 2)

⁸ Throughout Chapters 5 to 7, there are references to various activities or meeting that the researcher participated in at the school. The activity list contains information about each one and can be found in Appendix D. From this point on, only the reference number will be mentioned.

- A short outline of the typical information flow from teacher to students. A typical teacher making use of a number of media to deliver content can be generalised as shown in the figure blow. In the course of teaching, a teacher may make use of multiple media to deliver content to the students. For each one the teacher will need to create or adapt content using some interface. The content is then delivered to the students using one or more medium. Each medium may require different actions (interface) to be done in order to make use of it.

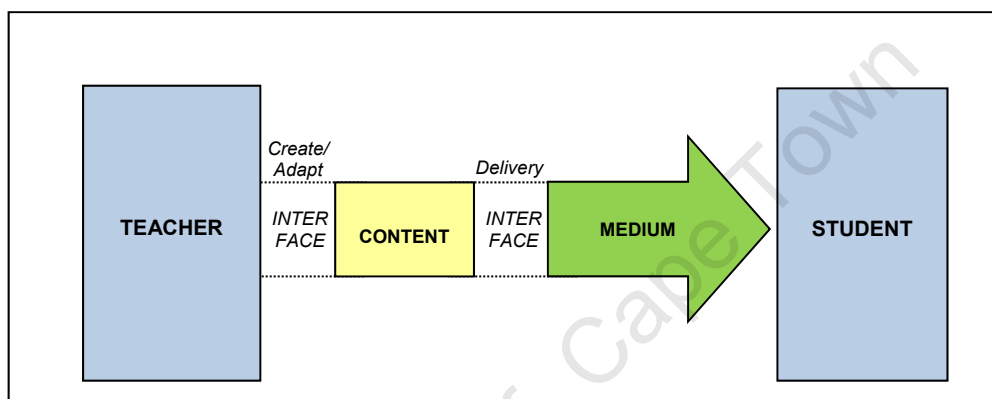


Figure 5.1: The normal workflow of a teacher making a medium to deliver content to students. This process is often repeated with multiple media.

Discussion and general brainstorming took place, starting from the last item presented. Examples cited by teachers of multiple media usage include the use of the whiteboards and written exercise. With the whiteboards, a teacher would often generate content on the fly and deliver it by writing on the whiteboard. With written exercises, the content generation process would be longer and require more preparation depending on the required objectives of the exercise. Most teachers would use a word processor to create or adapt existing content. The created content would then be duplicated and distributed to students in class. For some teachers the delivery of the exercises would also be done electronically through a website using Moodle (Moodle).

It was decided by the Planning Team that the initial focus would be to build the system upon which the teachers can deliver content to the students via the mobile medium. The user interfaces and the backend of the system to enable this would

need to be designed, while suitable content as well as the delivery methods would need to be explored as the system is built up. The Planning Team also broke down the integration effort into these objectives:

1. **Determine suitable content for delivery:** From the Mobile Device Survey results, the Planning Team selected suitable content to deliver over the mobile medium. The detail of this phase will be present in the next section.
2. **Design and build interface for teacher input:** For the suitable content chosen, the Planning Team will identify and work with other local components (IT classes, Design classes and other teachers) to create a user interface suitable for acquiring that content. We followed the EAR/Process approach combination methodology to do this. These iterations were known as T-Iterations and the detail of this component will be presented in the next chapter.
3. **Determine suitable medium for delivery to students:** We followed a similar process to teacher input interface design to create user interface suitable for student to acquire the content. These iterations were known as S-Iterations and the detail of this component will be presented in the Chapter 7.
4. **Design and build the backend system to process and store information:** The backend system was built upon the system already present at school as far as possible. Necessary modifications were made to allow teachers to add content or for content access as and when this happened. This would form part of either the T- or S-Iterations depending on the target user.

Figure 5.2 summarises the above four aspects. Note that EAR iterations were on going.

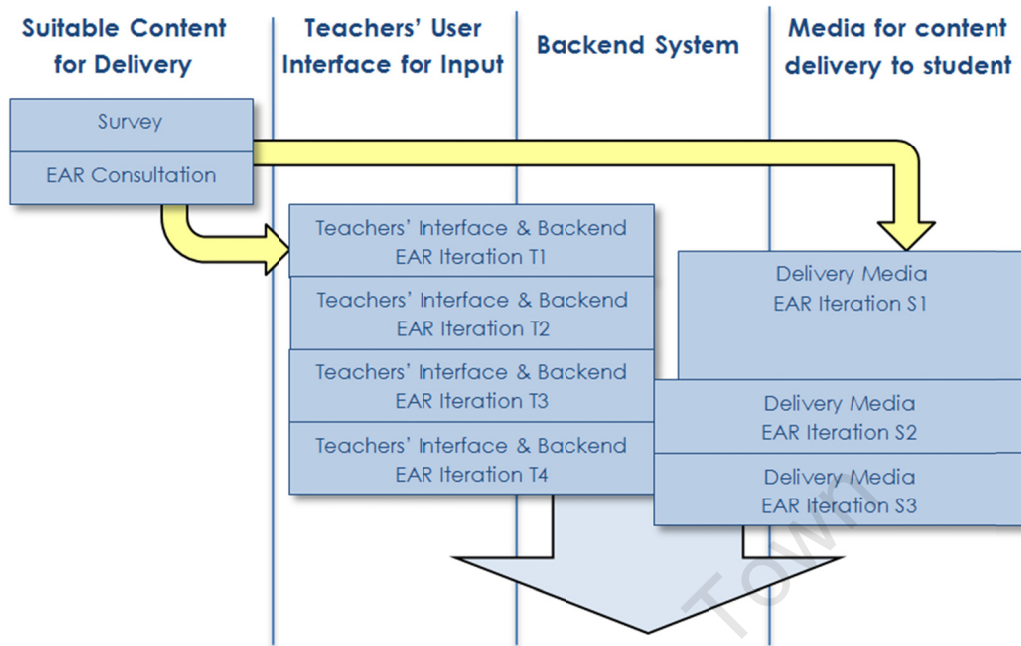


Figure 5.2: Summary of the four aspects of our integration effort with the EAR iterations

5.2 Suitable Content Chosen and the Relevant Results

Activity Reference: #STF01, #MTM01

The Planning Team considered the content that will be suitable for delivery over the mobile medium by looking at the results of the Preliminary Study and the Mobile Device Survey results that was originally outlined in Chapter 3. Input was also canvassed from the students and teachers via Life Orientation discussions. Relevant results are provided in this section.

Multiple content types were suggested in the Preliminary Study including:

- Homework information (required content & due dates),
- Test information and important dates
- Notes / Textbooks
- Help from teachers
- Videos / Podcast of class

Teachers in the Planning Team also suggested other content types such as slide shows, test results and marks. The Team considered all of these content types for the system to deliver, but had initial preference for the delivery of important dates, reminders and test results over the mobile medium for the following reasons:

- These were already something that every teacher is already doing. Providing other content types including notes, online help, podcast, and slide shows would require teachers to learn how to generate them for the new medium. This was not suitable for the first time integration.
- Since the content was already being generated by teachers, there were existing ways for them to be transfer from teachers to students – making teachers likely experts in providing them. This was important because it can act as an engagement point with the teachers – this is part of the ‘Beneficiary participation’ component of the Process approach (Bond & Hulme, 1999).
- These contents were short in nature and it was not time consuming to provide them.
- These contents were text-based. Survey results also indicated that all mobile devices used by students and teachers can receive text-based information with a Short Message Service (SMS) Message as the lowest common platform – Question 9S in the Mobile Device Survey). MXiT – a text-based chat service was also capable of being run in 99.2% of the phones we surveyed – Question 8S in the Survey). In Chapter 7, we present the full detail of that aspect of the study – the media used for delivery of this content.
- Homework and test information were rated as useful or very useful by the majority of students and teachers (Homework: 94.2% of student and 89.1% of teachers – Survey question 20S.1 & 20T.1. Test: 96.1% of students and 92.2% of teachers – Survey question 21S.2 & 21T.2).

- Delivery of both homework and test information was rated by teachers as useful or very useful for parents to know (Homework: 76.6% - Survey question 20T2.1. Test: 100.0% - Survey question 20T2.2)
- There were disagreements in providing notes over the mobile medium between teachers and students with the majority of teachers feeling indifferent (57.8% - Survey question 20T1.3) and the majority of the students (86.8% - Survey question 20S3) thinking that it would be useful or very useful. A similar disagreement also occurred with providing help over the mobile medium with 60.9% of teachers saying that it would be somewhat useless or useless (Survey question 20T1.4) and 92.2% of student saying that it would be useful or very useful (Survey question 20S4). It was felt that since the teachers would be providing the content that a good starting point for the teachers' interface would be for them to provide content that they feel would be useful.

However, there was room to explore how such information could be delivered to the students even though the teachers may not be keen on providing it. We will present the detail of this in Chapter 7 together with other work done to deliver content to the students using various methods over the mobile medium.

In the next chapter, we will provide the detail for the Planning Team's chosen content and the work to design suitable interfaces for acquiring this content from teachers.

6

Teachers' Iterations (T-Iterations)

Having decided that the delivery of homework, test information and results would be the initial content sent over the mobile medium, a way needed to be found for teachers to design the user interface of the system, while at the same time also explore the actual nature of the content that will be delivered over the medium. The Process approach encourages the use of existing local institutions to drive this design process.

The design process was entirely driven by the participants, although the researcher was present as one of the group – he operated within the role of a typical IT teacher. On occasions where this was not possible, the service provided outside of this role was documented and evaluated as outlined in Chapter 4. The researcher also did not push for a particular design methodology or process to be used other than the combinational PEAR approach outlined in Chapter 4.

6.1 The First two Iterations (T1 & T2)

6.1.1 Internalising User Interface Design

Activity Reference: #STF02, #AHM01

This was done by looking at similarities between user interface design and functions that schools have to do. This was found in the design of and filling in of paper forms. At the EAR site, the design of the forms used at the school was shared between the teacher in charge of administration and the deputy principal. Some forms were designed first by the teacher who needed it and then approved by the deputy principal, with modification if necessary.

The design guidelines used by the deputy principal were (derived from an interview with the deputy principal):

1. Follow the way people read from top to bottom and left to right.
2. Number each step, if there are steps to be followed (especially important if the form is to be filled in by students). This will ensure that the filler does not miss out on steps and for the person at the office to see that no steps have been missed.
3. Do not give more space than necessary – rather wait for a request for more space to come through. Most spaces are not used fully.
4. Use tick boxes for more popular choices first. Sometimes, the popularity of the choices only comes through in subsequent versions of the form. Teachers will rather tick than write.
5. Offer questions and choices in a line rather than in a column
6. Use consistent colour paper so teachers and students can recognise the correct form quickly. (Forms at the school are often referred to by students and teachers by their colour instead of by name.).
7. Signatures or initials are always necessary for verification.

It was clear that the teacher in charge and the deputy principal were very good and experienced at designing forms. They had a clear understanding of what made good forms and the importance of the form filler being able to fill it in correctly and efficiently, as well as for the form processor to do his/her job correctly and efficiently. The skill that the form designers had was the ability to determine what information was necessary on the form as well as how it should be put in the form to allow for maximum efficiency by both the filler and the processor. These two skills were exactly what we needed in the design of the user interface as well as determination and presentation of the type of information that would be required to be input and processed.

6.1.2 Goals for the First Two Iterations

Activity Reference: #STF02

1. Form a design team with teachers to create a suitable form to collect homework information.
2. To discover what information was required to be stored and how it was currently being done.

6.1.3 Existing Methods

Activity Reference: #STF03

Prior to the introduction of the integration, teachers were already communicating homework and test information to students. We looked to these communication methods to find out what information was being sent and how. We discovered that such information was sent in a number of ways:

- Verbally and students would write in their homework diary
- Written on the whiteboard in each classroom for students to write in their home diary
- Combination of both

Over a period of one week, photographs were taken of homework/test information written on the whiteboard. This was done for each classroom either by volunteer students during homework sessions⁹ or by the cleaners after class before that day homework was erased. Sample entries in the diary of the students were also photographed by the mentor during their bi-monthly meeting (Mentors will normally check the student's diary in any case).

From these data, we were able to determine that each work item (homework, test etc.) typically include the following information:

- **The subject and the grade for which the test or homework applied:** The subject information was often missing on the board because the student will

⁹ This is period at the end of the school day when students are expected to do homework.

know the subject for that classroom. Most students did, however, write down the name of the subject in their diaries.

- **Date on which homework is due or the test will take place:** At times this information was written as 'tomorrow' instead of the date (or both). Some students wrote the same information on the date that it was given out and also on the due date in the diary. Some only did one or the other.
- **The Type of information:** The default type (one without any indicator) is homework on both the board and diary. Additional indicators included the fact that the information concerned a test, was a Continuous Assessment (CASS¹⁰) work, was an ongoing project or indicated as another type such as field trip.
- **Detail:** More detail on the work item such as the page numbers from the text book, exercise number, what the test will be on etc.

All teachers who wrote on white board have a pre-allocated area where such information was written. This was often on one side or a corner of the board. There was also a request that the information did not get erased (PDNE – Please do not erase) to other teachers using the classroom after and the cleaning staff.

Abbreviations were used and seemed to be well known by the students. These included 'EX' for exercise, 'Pg' for Page, 'Prj' for project. Textbook names were also abbreviated in a variety of ways including calling them by colour (*Green book*), initials of the author (*JG*). In some subjects with only one book, there was no reference to the book at all (just pg 2-3, ex 10).

Not all students copied down the information into their diaries, but those who did copied the information down mostly verbatim along with the subject name. Students who did not copy down the information relied on their friends or their own memory for what is required (In the Preliminary Study, this was the main reason why students would prefer to receive this information over the mobile medium).

¹⁰ CASS tasks are continuous assessment tasks which count towards 25% of the final year mark. Students are told of this status so that they will put in the required effort.

6.1.4 Input Form Version 1

Activity Reference: #STF03, #STD01

The first version of the homework/test information capture form was produced and introduced to teachers. Teachers were already aware of a project that will allow information given to be queried by students from their mobile device. However, the information was not available to students in this iteration so they did not have to be overly concerned with accuracy.

One sheet was used for each day and a set of five was given for one week. Each sheet was returned before the start of the homework session. During the homework session, student volunteers¹¹ capture the information on the form to a spreadsheet. There was no formatting of the spreadsheet given to the student. They were each told to create a spread sheet to capture the information. They were free to modify the spreadsheet as they went along if they thought the changes were necessary. Students also gave brief feedback on their capturing experience after each session to the Computer Applications Technology (CAT) teacher. A meeting to discuss spread sheet format was held at the end of the test week with the intension of standardising the spreadsheet to be used in the second iteration.

On the other side of the form there was a feedback area where teachers could make suggestions on how the form can be improved. This information was also captured by the volunteer students. After two weeks, the teacher in charge of administration also discussed with the teachers individually prior to and as a group during a staff meeting for feedback on the form.

¹¹ Students who were studying Information Technology or Computer Applications Technology. They were well versed in the use of a spreadsheet program.

Version 1 of the form (reduced to fit – original form takes up entire A4 page and contains space for seven periods)

TEACHER: _____ DATE: _____

PERIODS	Detail	Type (Homework, Test, Exam CASS, Project, etc.)	Due Date / Time
1			
2			
3			

Figure 6.1: Version 1 of the input form as designed by the teachers involved

6.1.5 Reflection from Iteration T1

Activity Reference: #STF05, #STD02

Relevant feedbacks on the first version of the form were as follows:

- There was only space for one item – at times there were multiple items such a test for the next day and homework.
- There was confusion on what to do with item that needed daily reminder. For example when there was a test in 5 days' time, should one indicate the test every day for 5 days? Some teachers raised the point that this should be left up to the teachers to decide.
- Teachers did not always use the type name suggested e.g. homework is sometimes called assignment.
- Teachers would write down tomorrow instead of the actual date.
- Many teachers had more than one class for the same grade/subject combinations (for example, a teacher had two Grade 10 mathematic classes in one day). For such cases, the teacher would write "same as period 2" instead of rewriting the same information.

- The form cannot be a replacement of the whiteboard (or other form of note that the teachers used to keep track of the work themselves) as it did not get returned to the teacher and as such teachers still had to do both.
- There was no clear reasoning for the purpose of the form – although they understand that it will eventually lead to a system that would send out reminders to students.

The following feedback was received from the capturers:

- Illegible handwriting made the information very difficult to read.
- Inconsistent type name (homework, assignment, test, exam etc.) made it sometimes confusing to record down the correct type. This also made it time consuming.
- Since the name of the subject was not recorded, this made the task of capturing quite complex as students needed to look up that information by cross-referencing it with the particular teacher's timetable.
- At the end of the week, the students involved discussed the formatting of the spreadsheet. Only the students took part in the discussion while the CAT teacher and the researcher observed what was decided upon. After some discussion, a format was settled upon. It was almost the exact sheet used by one of the students who happened to be the top CAT student. It was made clear to the students though that they could make modifications to the sheet in the second iteration but it would have to be agreed upon by everyone first.
- Interesting observations about the spreadsheet included:
 - The columns were in the same order as they appear on the form
 - A drop down list was created for the type of information
 - An input mask was created for the dates so that the user would have to enter dd/mm/yyyy format.

Figure 6.2 summarises what happened during the first iterations of the form design process.

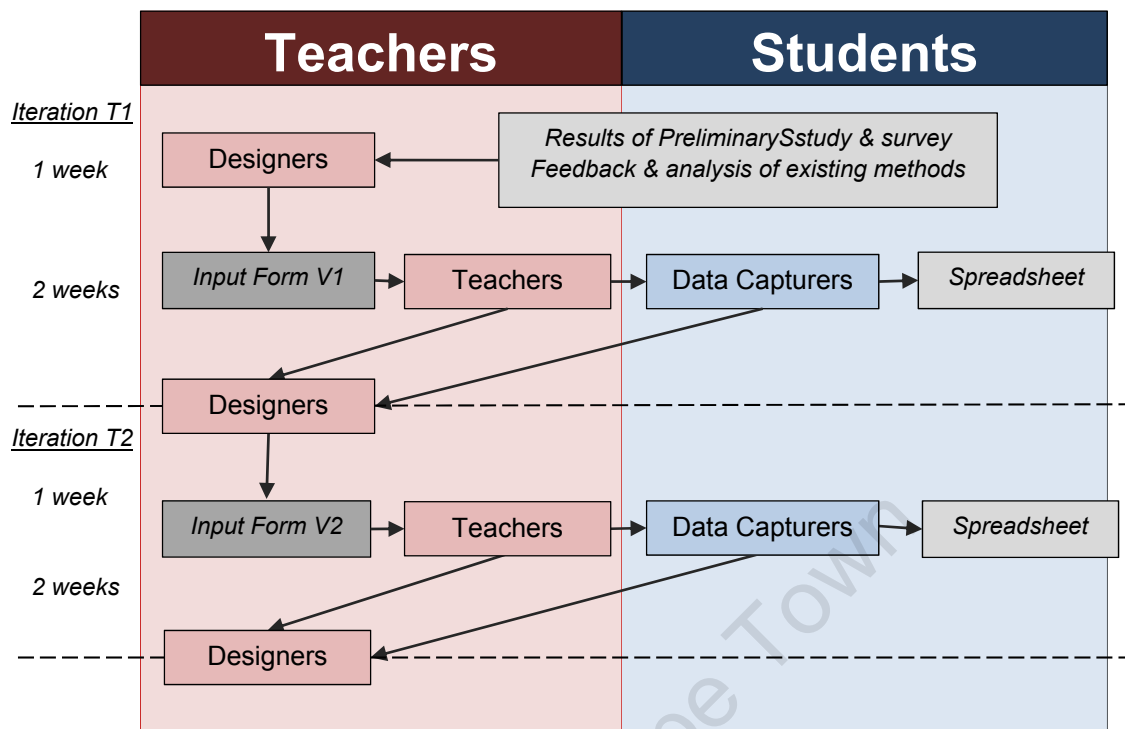


Figure 6.2: Summary of information flow between the groups of people involved in iterations 1 and 2

6.1.6 Input Form Version 2

Activity Reference: #STF05

Version 2 of the input form had the following modification to address issues pointed out above:

- There were now two spaces for every period. The maximum number of items used by teachers was two and consultation with all teachers also indicated that two should be enough although they were sure there would be occasions where more than two will be necessary.
- Addition of columns for the type of item (homework, test etc.) so teachers could tick what it is faster and this was also easier to process by the capturers.

TEACHER: _____ DATE: _____

Chapter 6: Teachers' Iterations (T-Iterations)

6.1 The First two Iterations (T1 & T2)

PERIODS	Detail	Type Tick applicable						Due Date / Time
		Homework	CASS	Project	Test	Exam	Others (indicate)	
1								
2								
3								

Figure 6.3: Version 2 of the input form as designed by the teachers involved.

The second version of the form was used for another week and feedback was obtained from teachers in a similar manner as with the first version.

6.1.7 Reflection from Iteration T2

Activity Reference: #STF06

After two weeks of usage, the teachers in charge of administration (after discussing the form with the other teachers) suggested that it would be easier for teachers to not have to refer back to the top in order to see what the type of the item is. This can be fixed by using checkboxes instead of a column for the type. Feedback from the teachers also indicated that this might be preferable as well. The two rows per period seemed to be enough as no teachers commented on this. Issues not yet corrected with this version were also pointed out including lack of purpose and duplication of information on whiteboards and the form, (both still not corrected from the first version), illegible handwriting and the cross referencing that must still be done by the capturer in order to figure out which class/subject the work item applied to. There was no modification to the spreadsheet.

6.2 Iteration T3

6.2.1 Input Form Version 3

Activity Reference: #STF07

To address the issues raised, customised forms were created specifically for each teacher for each day. These customised forms allowed for the following:

- As forms were printed each day, it contained information specific to that day. This gave the form a purpose since it allowed teachers to discontinue writing the same information on the whiteboard, since they now had access to the information written down for each day.
- The actual date and the subject name could be printed on the form. This also meant that not all seven periods have to be printed out. Teachers only taught a maximum of six periods, allowing for more spacing to be used. This also allowed the capturer to not have to cross reference the teachers and period in order to find the right class.

A sketch of the third version of the input form is shown below. A customised form was printed out for each teacher each day.

Period	Detail	Homework Detail
1	<u>Physical Sciences</u> <u>Grade 11</u> <u>Rm 12</u> Events for today <u>Homework: Pg 25 Ex 3.1</u> <u>Test : Electrolysis</u> Upcoming: <u>Homework : Summative Pg 29</u> <u>due : Wed 21 April</u> <u>Test: Waves</u> <u>Date : Wed 5 May</u>	Item 1: Detail <div style="border: 1px solid black; height: 40px; width: 100%;"></div> Type: <input type="checkbox"/> Homework <input type="checkbox"/> CASS <input type="checkbox"/> Test <input type="checkbox"/> Exam <input type="checkbox"/> Other: _____ Due <input type="checkbox"/> Next Day <input type="checkbox"/> <u>Thu 22</u> <input type="checkbox"/> <u>Fri 23</u> <input type="checkbox"/> <u>Mon 26</u> <input type="checkbox"/> <u>Tue 27</u> <input type="checkbox"/> Other: _____ Time: <input type="checkbox"/> Period <input type="checkbox"/> Other: _____ Item 2:

Figure 6.4: Sketch of the version 3 of the form - underlined text indicated that it must be generated by the system

While the form design team set out to design a form that caters for the above as well as addressed previous concerns not yet addressed, a way to generate these customised forms automatically needed to be made.

6.2.2 Goals for the Iteration T3

Activity Reference: #STF07

1. To create customised but still paper-based input form that would be useful for teachers in terms of presenting tasks due for the day as well as upcoming events.
2. To create and test a computerised system that would generate the customised (but paper-based) input form for each teacher as well as to capture the results.
3. To familiarise teachers further with the user interface of the above by exposing them to the paper-based form.

4. To familiarise students to the data input interface (that they will be capturing the information) so they could help teachers when they were eventually introduced to the computerised system.

6.2.3 Towards the Computerized System

Activity Reference: #STF07, #STD08, #STD09, #STD11

The third version of the input forms needed to be printed by a computer system as information for each teacher must be dynamically queried and built each day. As a result, the design of the third version of the input form was given to the IT Club members¹². The group together with their IT teacher (the researcher), took input from the data capturers (some of whom were also part of the IT group) and developed the system necessary to generate the form dynamically each day. This system is described in more detail in the next section.

The system used - referred to as Electronic Information System (EIS) in this thesis) generated customised input forms (also known to the teachers as the Homework Description Form) as shown below. The left hand side contains work due for that day (indicated as today on the form) as well as any upcoming homework or test. The right hand side contains spaces where teachers can write down homework or test information. The due date is generated by the system to contain "next day" and actual calendar date. There is also an *Other* field to indicate other dates not printed.

Homework Description Form - Mrs [REDACTED]			FOR Wed 21st May 2008
P	Subject Detail	Homework	T103/080521
4	Mathematics Grade 10 Room 11 41110 Events for today HMW: Simple Interest -> Do example 1 and 2 pg 39 Upcoming	Item 1 DETAIL: SI = pg 40 NO 4-9. Type <input type="checkbox"/> Homework <input type="checkbox"/> CASS <input type="checkbox"/> Project <input type="checkbox"/> Test <input type="checkbox"/> Exam <input type="checkbox"/> F/Trip Due: <input type="checkbox"/> Next Day <input type="checkbox"/> Fri 23 <input type="checkbox"/> Mon 26 <input type="checkbox"/> Tue 27 <input type="checkbox"/> Wed 28 <input type="checkbox"/> Other: Time: <input type="checkbox"/> Period <input type="checkbox"/> 8:15 <input type="checkbox"/> 15:30 <input type="checkbox"/> Other: Duration: Item 2 DETAIL: Type <input type="checkbox"/> Homework <input type="checkbox"/> CASS <input type="checkbox"/> Project <input type="checkbox"/> Test <input type="checkbox"/> Exam <input type="checkbox"/> F/Trip Due: <input type="checkbox"/> Next Day <input type="checkbox"/> Fri 23 <input type="checkbox"/> Mon 26 <input type="checkbox"/> Tue 27 <input type="checkbox"/> Wed 28 <input type="checkbox"/> Other: Time: <input type="checkbox"/> Period <input type="checkbox"/> 8:15 <input type="checkbox"/> 15:30 <input type="checkbox"/> Other: Duration:	

Figure 6.5: Version 3 of the input form as designed by the teachers involved

¹² The IT Club was formed as an extracurricular activity for any students (not necessary just IT students) interested anything IT. The Club explored animations, robotics, game making and advanced programming over the years. The Club was run by the IT teacher.

All forms were collected daily and processed by the data capturer using the same system used to print out the form. For capturing, the system displayed HTML forms instead of flat boxes and checkboxes used for printing.

The system stored the data in a database table whose structure was based on the capturer's spreadsheet. The design of the database tables was done by the Grade 12 IT class as part of their syllabus. The students also created SQL statements to select, insert, delete and update information. Modification to the structure was done by the researcher to optimise the table (e.g. Addition of primary keys and further normalisation of the tables).

The printed versions of the form as well as the capturing interface were done using the same code and are shown in Figure 6.6 below.

Homework **T130/080520**

Item 1

DETAIL: Act 7 (p92)
Summative assessment (p 104)

Type ☐ Homework ☐ CASS ☐ Project ☐ Test ☐ Exam ☐ F/Trip

Due: ☐ Next Day ☐ Thu 22 ☐ Fri 23 ☐ Mon 26 ☐ Tue 27 ☐ Other:

Time: ☐ Period ☐ 8:15 ☐ 15:30 ☐ Other: **Duration:**

Item 1

DETAIL: Act 7 (p92) Summative assessment (p 104)

Type ☒ Homework ☐ CASS ☐ Project ☐ Test ☐ Exam ☐ F/Trip

Due: ☒ Next Day ☐ Thu 22 ☐ Fri 23 ☐ Mon 26 ☐ Tue 27 ☐ Other:

Time: ☒ Period ☐ 8:15 ☐ 15:30 ☐ Other: **Duration:**

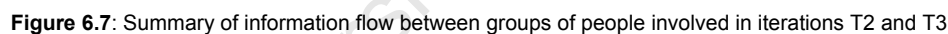
Figure 6.6: Paper-based forms (top) were filled in by the teachers. Students then capture the detail written on paper using a digital form set up in the same format

The number on the top right corner of each form uniquely identifies the teacher and the date (T130 is the teacher code and 080520 indicated 20 May 2008 as the date). The data capturer only had to enter this number at the start to bring up the correct input processing page for that form. The electronic version of the form that is identical in layout is then shown on screen ready for the capturer to type in the relevant detail.

This was run for four weeks allowing for:

- **The form to be more useful for teachers:** The four week run allowed the teachers to see the benefit of the system they had been working towards. Whereas, in the first two versions of the form, there were no direct benefits to the teachers, this version now had the printout of what work was due as well as upcoming deadline details. This saved the teachers from having to look this information up for each period.
- **The form to be built on further:** Feedback on the form layout and text were also taken in by the designers and subsequently given to the IT group. These changes were minor spelling errors, but additional field items were also added.
- **Teachers to get used to the paper-based forms:** The teachers saw this as a continuation of the previous versions. However, the plan was that the next version of the form would be electronic and reflect exactly the same layout as the paper-based form. In fact, the capturing form being used by the data capturer would eventually be used as the interface for the teachers in the next iteration. In effect, the teachers are being trained to use the new electronic interface indirectly.
- **The data capturing form to be tested:** The data capture forms were able to be tested by the data capturers. The glitches were addressed prior to being used by the teachers.
- **The backend processing to be tested:** Data captured was stored and used to print out the next version. This also allowed it to be tested while the teachers were not exposed to any bugs or glitches.

The diagram on the next page summarises the information flow between the different groups of people during iterations T2 and T3 as described above. We then describe the technical detail of the EIS system as well as the contribution made by the IT Club.



Activity Reference: #STD08, #STD09

- The PHP language is very similar to JAVA the language used in the IT class.
- The database connectivity model used by LAMP servers (PHP-MySQL) was within the curriculum for the IT class.

- No additional hardware was required as the server was available
- The server is already accessible internally from within the school making the capturing interface available in the computer rooms where the students can capture data in the homework session at the end of each day as well as in the administration office where the forms can be printed for each teacher daily.
- Furthermore, the web-based output would also allow the interface to eventually be deployed to the classrooms in the next iteration. However, computers were not present in all classrooms and this will need to be done as part of the next iterations.

6.2.5 Roles of the IT Classes, IT Club and the IT Teacher

Activity Reference: #STD08, #STD09, #STD10

The table below shows the various development activities for the backend of EIS and the people who did the work.

Table 6.1 – Summary of the development activities by various groups involved.

	IT Classes	IT Teacher	Researcher (activities outside of teaching)
LAMP Server installation & Maintenance		Database user account creation & backup. These tasks are normally done as part of the Moodle server maintenance	
Database Structures	Discuss & design table structures from spreadsheet	Teach Database structure theory	Implement designed database with optimization modification
SQL Queries	Develop SQL queries to insert, delete and update database content	Teach SQL as part of the normal IT Syllabus. Also helped students in developing of queries	

	IT Classes	IT Teacher	Researcher (activities outside of teaching)
Translate word version of Form to HTML	HTML learned as part the subject	Teach HTML	
Process PHP to query from and make changes to the database	Database connectivity is part of syllabus but a group of students learned this as extra-curricular activity	Teach PHP & related concepts as part of extra-curricular activity	Support code written Verify code works as expected
Login & Input form selection system	Designed forms and code HTML & Base PHP pages	Teach relevant concepts	Implement code around security

It should be pointed out that the above activities done by the researcher that were outside of the scope of the Information Technology syllabus were reasonably within the ability of a typical IT teacher. This was because they are within the bachelor level degree in Computer Science or similar qualification that the teacher was expected to have (South African Department of Higher Education and Training, 2008).

6.2.6 Reflection from Iteration T3

Activity Reference: #STD12, #STD13, #STD13, #STD16, #STF13

Feedback from teachers:

- Positive comments were received about tick boxes for type, due date and time appearing for each item instead of as columns.
- Only specific periods were listed resulting in space saving as well as time. Previously teachers had to skip the period they were not teaching.
- Printout of items due on the day and upcoming events were well received by teachers. Three teachers said that they read out the items on the upcoming list at the end of each lesson.

- There were indications that whiteboard notices of these events were still useful for both the teacher and the student as they were visible in class and there was therefore no excuse for not being able to see it.
- Complaints were received on the size of the text as some teachers found it too small to read.

Data Capturers

- Illegible handwriting remained an issue.
- Some issue with validation rules for entering date and time were picked up. Teachers did not consistently use the same notation (egg 2.15pm and 14.15 or 14:15). There was some manual conversion that must be done prior to entering data. Suggestions were made that a calendar-based selector be made available instead of typing in the required format.
- There was also report of teachers not ticking the box but rather underlining or circling. This was not a problem, however, as the intended selection could be interpreted in both cases.
- The data capturing interface matched up with the printed form making it easy for the data capturing to be done.

IT Club/IT Class

- Applications of learnt concepts for 'real world' software have been a valuable experience. Some students have indicated that they only gained understanding of the concept on developing the various components of the system.
- With some of the members of the group having worked as a data capturer in the first two iterations, their understanding of the data that need to be stored has been valuable. These students were able to base the design of some of the database tables on the spreadsheets.

Form Design Team

- Some input received from the data capturers was more technical in nature in this iteration (e. g. Use of calendar-based selector).

Figure 6.8 summarises the activities that took place in iterations T3 and T4.

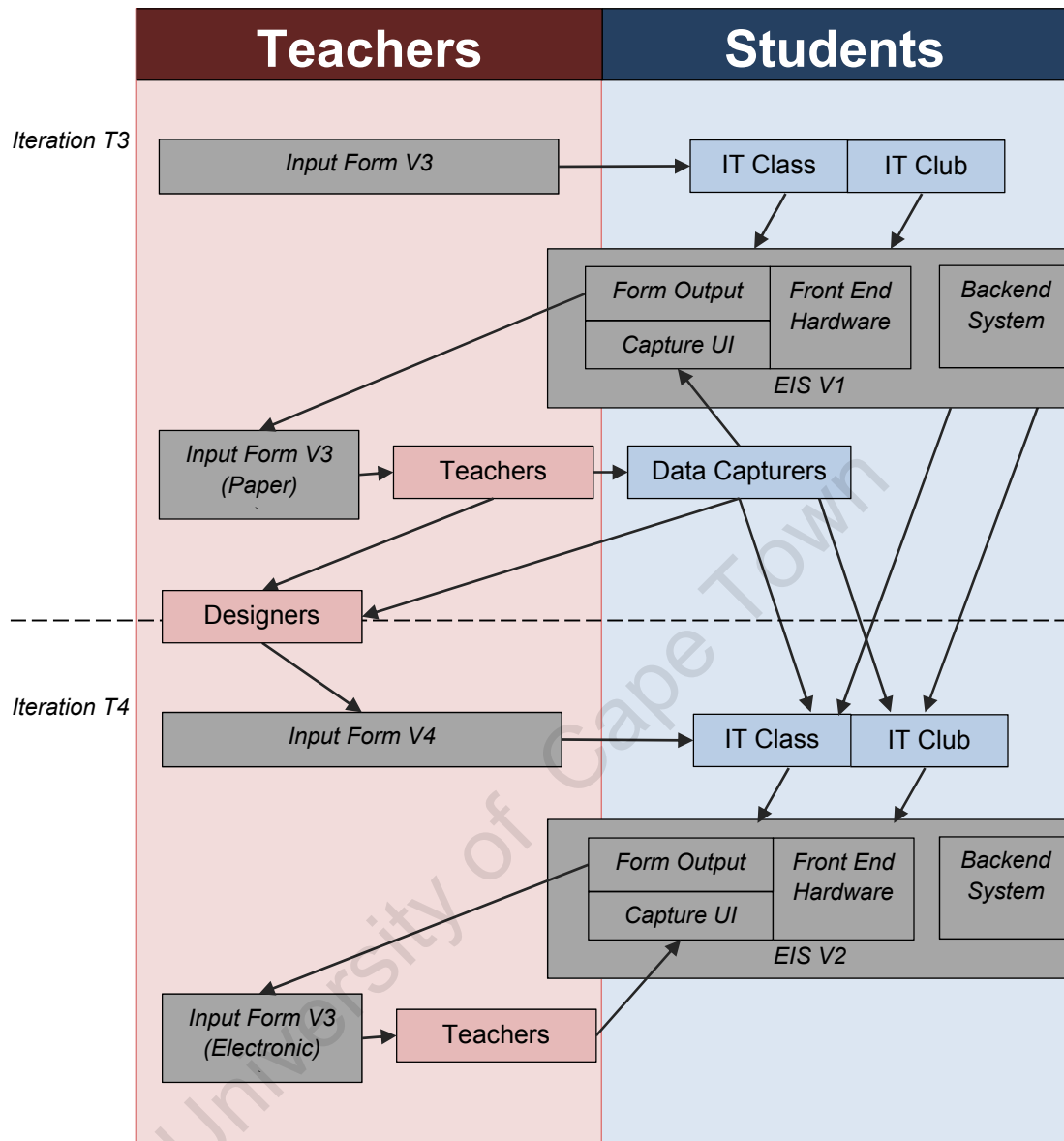


Figure 6.8: Summary of the information flow between various groups of people involved in iterations T3 and T4

6.2.7 Towards Iteration T4

Activity Reference: #STD16, #STF13

The diagram above shows the link-up between iterations T3 and T4, in iteration T4, the teachers would fill in the input form electronically via the web interface (the same form that the student data capturers had been working with). Since the web-interface and the paper-based form were identically laid out (as confirmed by the

students), the Planning Team anticipated that the teachers would not need any additional training prior to the introduction of EIS, except for the login interface. We also planned for the student data capturers to act as first line of support for the system as they were very familiar with the interface. With the training and support aside, the main issue that needed to be addressed in the next iteration was not one of software training and support but rather one of equipment.

6.3 Iteration T4

Activity Reference: #STD17, #STD18, #STF13

Most of the work necessary for this iteration took place during the school holidays and involved the preparation of the classroom computers that will deliver the web interface for teachers to input homework and test information. At that stage, not all the classrooms had a computer but all of them did have network points. Only classrooms with projectors had computers installed. Discussions at the Planning Team meeting with the school indicated that there was no budget for this purpose, but – since there were old computers that were to be written off – these computers could be salvaged for this purpose. However, this meant that the support for the hardware would also need to be taken care of by the school as there was no maintenance budget for them either. The problems that needed to be solved are thus two folds:

1. Installing of appropriate software for the outdated hardware so that the web interface could be delivered to the device. The software should also be suitable for use in the classroom purpose.
2. Arriving at a maintenance programme that will ensure that the outdated hardware and software continue to function.

6.3.1 Hardware and software installations

Activity Reference: #STD19

The planning phase for this component was conducted by the IT Club, IT teacher and the staff member in charge of equipment (including IT-related) at the school. In

order to ensure that the hardware was set up appropriately, the following input were sourced:

- The capability of hardware and the operating system that could efficiently run on it.
- The requirements in terms of security that may be of concern to teachers since the computers will be situated in the classroom where students will have access to it.
- Suitable browser that will run efficiently on the hardware and chosen operating system and security policy.

6.3.2 Concerns

Activity Reference: #STD17, #ADM02, #STF15

We collected information from the teachers regarded security concerns in the following ways:

1. Interview teachers with computers already in their classroom on how they ensured that students did not have access to the computers when they were not in the classroom especially during break when the classrooms were not necessarily locked.
2. Interview the staff member in charge of IT equipment on the specification of the computers which were to be used as well as the operating system that originally came with the hardware. The IT security policy already in place at school was also discussed including the physical security of computers in classroom.
3. Raised a point of discussion in the weekly staff meeting on this issue.
4. Discussed the potential security concern with IT students with follow up assignment on what the main concerns are and how they could be prevented.

The researcher performed the interviews for (1) and (2) as a member of staff as well as raised the point of discussion in (3). Grade 10, 11 and 12 IT students discussed the issues in (4) separately and assignments were set for all three grades.

Concerns around deployment of computers in the classrooms were as follows:

- Students may want to use the computers located in the classroom to add or modify homework item. This should be prevented from happening.
- The settings for the computers needed to be protected from change. This included both the operating system and the browser software.
- The computers may not be fast enough to perform other tasks that the teachers may want to do such as word processing. This may have the effect of slowing down the computer. Teachers should be discouraged and/or prevented from starting other programmes.
- Viruses and other malware may be transferrable to the system and this needed to be prevented or minimized.
- Software support that may be necessary for some teachers who may not be familiar with the system as they joined the school after the initial phases.
- There was a need for maintenance of hardware and software outside of the normal maintenance programme as these systems are not covered by the school's maintenance cycles.

6.3.3 Addressing these Concerns

Activity Reference: #STD17, #ADM02, #STF13, #STF16, #STD21

Usage guidelines were compiled by the CAT teacher in order to prevent many of the concerns, while some were addressed by incorporating changes to the software.

1. Teachers should log out of the system when they are no longer requiring the use of the system, especially when leaving the classroom.
2. Teachers were encouraged to make use of stronger passwords. Guidelines on choosing secure passwords were circulated.
3. Teachers should check homework and other entries often to ensure that there is no entry that was not added by them.

Furthermore, additional changes to the system were recommended.

1. The system auto-logout during breaks to further prevent unauthorized usage outside of class time.

2. Software be set up in such a way that it was not possible for changes to be made to the operating system and browser.
3. The system must not perform any other functions and connection of external storage devices to the system should be disabled to prevent to use of the system for other purpose as well as to prevent transfer of computer viruses to the system.

In terms of maintenance, the following efforts were made in order to ensure that the system, software and hardware, are in good working order.

1. A number of spare computers not used in the initial deployment were set up and were available for swop out which can be done relatively quickly.
2. Image of the system be stored and used for system recovery. When a problem arises that is not hardware-related, images are replaced with a fresh copy. This saved a tremendous amount of time.
3. IT Club members were trained to swop out computers and to deploy new images. Additionally, the system was set up so that every classroom computer pings the server at regular interval. At the end of each day, an IT student made rounds to the computers which were not pinging. The image is replaced if the hardware is found not to be faulty or the entire hardware is replaced (with software image already deployed). The entire process typically took less than 10 minutes per machine.
4. The IT Club and classes made use of the hardware and software maintenance process as an opportunity for real world applications of their knowledge. This ensured that new students were taking up places of older ones as they completed their studies.

In terms of supporting teachers who may not be familiar with the system, the following were done

1. Students who acted as data capturers were familiar with the input system, and were spread out in different classes throughout the school. As a result, the teachers were able to call upon them for help in using the system.
2. Teachers who were unfamiliar with computer systems have the choice of filling in the paper-based forms and have their content captured by students after class.

3. New students are trained in entering the data from the paper-based forms ensuring that more students were available as older students complete their studies and leave the school.
4. A short guide outlining how to make use of the system was included in the teachers' how-to manual (available for other tasks and not only for our system). The guide was developed by the capturing team with the help of the CAT teacher.

6.3.4 Technical Detail of the System

Activity Reference: #STF15, #STD18, #ADM03

The software for classroom computers were selected and installed by the IT teacher/researcher with help from the IT class and IT Club. The computers were scheduled for disposal as they were in their fourth year. The machines had the following specification: Intel Celeron 2.5GHz CPU with 512MB of RAM and 20-40GB Hard disk.

The following modifications were made.

- Windows XP with the bare minimum required to run a networked environment was installed. Examples of the operating system modules not installed were games, printer services and accessories. The process undertaken to decide this was to install windows XP with the class deciding on whether each item selectable during installation were necessary.
- Windows XP was then modified to run in kiosk mode – that is automatically logged in and start a browsing session with a specific internal address of the backend server. Kiosk mode also ensured that the user was not able to run any other software or make any changes. This was achieved by setting an IT task for the IT Club members to research the different way to achieve kiosk mode for Windows XP. The operating system did not come with an out-of-the-box method to achieve this but there were many different ways for this to be done. Some involved changing settings and modification of the registers. Three different methods to achieve kiosk mode were proposed and implemented on the machines by the students and the results discussed.

- The browsing software was also selected for its ability to run kiosk mode. IT students were split up into teams to research how to turn the main popular browsers – Internet Explorer, Firefox, Opera and Chrome to run in kiosk mode. The eventual choice was Opera due to its built-in ability to run this mode.
- Other requirements such as the disabling of the USB-connected storage device were also incorporated by means of registry modification as researched by the students.

Once the best kiosk-based configuration had been chosen and installed, the initial system was cloned using Clonezilla¹³ onto three other identical machines. They were then tested on by Grade 10 IT students who were asked to attempt to get out of kiosk mode and to see if they could make the system fail. A number of discoveries were made including

- Students were able to enter any address of their choice by pressing F2 on Opera. However, since the machines were not configured to use a proxy server, the requests were not being forwarded to the Internet.
- Students were able to shut down the browser by using alt-F4. Further research allowed for the disabling of this via modification of a register setting.

Once further modifications were made, the images were duplicated by the IT students to the other machines and deployed to the classrooms. Each machine was given a different IP address and noted down for future identification purpose. The students also tested that each one worked as intended.

6.3.5 Reflection from Iteration T4

Activity Reference: #STD22, #STD24, #STF18, #STD25, #STD27

The same process of gathering reflections from teachers and students took place after iteration T4.

¹³ Clonezilla is a free software that can be used to duplicate disk images from one computer to the other so that they both appear identical afterwards.

Feedback from teachers:

- Teachers reported few technical issues with some even commenting that the EIS computers functioned more reliably than the other computers used in the school. This was an indication that our maintenance programme was working.
- An average of eight issues was reported per week but most of those (90.2% of them) were related to the accuracy of the class list (which at this stage was manually entered resulting in delays in ensuring that the class list was up to date).
- The increased text size was well-received by teachers.
- Real time indication of the time remaining in the period was requested. This was because the system auto-log out teachers at the end of the period and the teachers needed a more accurate way to determine when this would happen.
- Teachers reported that the student maintenance and support team were more helpful than the IT maintenance team hired to oversee the school's computer system. The students were also knowledgeable about the EIS system.
- Three teachers (including the IT teacher) also made use of a learning management system called Moodle to give assignment details and take in work. Two of the teachers have mentioned that since they have to do a similar thing in Moodle that it would make sense if the EIS system could retrieve that information from Moodle.

Data Capturers

- There were only two full time teachers and three part-time teachers making use of the paper-based form. This meant that there was relatively little work for the data capturer to do. It was still good that they had a chance to do this as it kept them familiar with the system so that they could still help the teachers.

The maintenance team (IT Students)

- Students had a chance to apply what they have learnt in class – hardware and software installation – as well as topics over and above the syllabus. This included managing software images and user support. Selection and installation of software were done mainly by the IT Club as a group and the students gain working knowledge of software installation as well as basic knowledge of security.

6.3.6 Towards the Next iteration

Activity Reference: #STF20

The next iteration would need to deal with the accuracy of the class list. One of the ways to deal with this is to link up to the school's administration software's SQL database to obtain information about students, timetable (Class, teachers, period), marks, parents' information etc. Another possible link is to Moodle via its MySQL database. As both these links involve the use of a SQL database, the IT class would have been able to do part of the work in this regards. However, more complex SQL queries were still done by the IT teacher.

However, this is the stage that was arrived at by end of our Study. However, the Process approach is ongoing and in the next iteration it was hoped that the above issues would be dealt with.

In the next chapter, we present the events that happened during the S-Iterations.

University of Cape Town

7

Students' Iterations (S-Iterations)

While the teachers' input interface and the backend system were being developed in the T-Iterations, a parallel process to identify the media over which the content would be delivered was also started in the S-Iterations. The same Planning Team was involved in the processed-based approach for this aspect as well. However, the two systems were not linked until iteration T3 because it was only at that stage that information gathered from the teachers was being stored in a database. Prior to that the exact information as well as its format had not been settled and were only being captured on to a spread sheet. The figure below shows the time line of where the two iterations match up against the tasks that needed to be done.

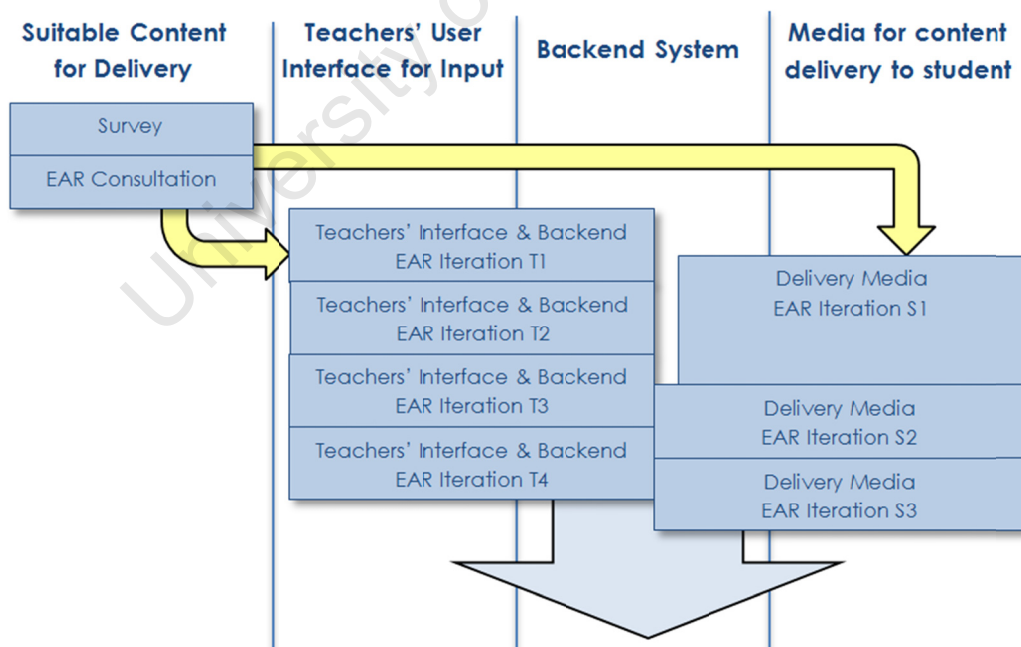


Figure 7.1: Summary of the four aspects of our integration effort with the EAR iterations

7.1 Participants and Mobile Devices

7.1.1 Participants

Activity Reference: #STF04, #STF05, #MTM01

Although the same Planning Team also worked on this aspect of our study, we realised at the start (at a suggestion of one of the teachers) that participation of students would be very valuable for the planning of this aspect as it is them who will be assessing the information via the selected media. However, the main problem was not to identify suitable students to take part in the planning phase (there were a lot of volunteers for this), but rather how to involve the chosen volunteers. It was felt by the teachers involved that the same planning procedure used in the first iteration (T1) of the interface & backend development aspect that involved everyone in one room was not going to work. This was because they felt that students would generally not offer their honest opinion in such situations when present with teachers as they may either be too nervous or offer answers that they think the teachers would want to hear. Due to this, input from the students was gathered separately to the teachers. Input from students was then discussed at the Planning Team meeting and any studies to be done were considered there.

As outlined earlier, at the participating school, each student is allocated a teacher who will act as the students' mentor for the year. The mentor also teaches the student in the subject Life Orientation (LO) which occurs twice per week. They also meet up with the student for one on one discussion once to twice a month. The LO classes were sometime used to canvas students' opinion on various issues – including this case as it was felt that the topic was relevant to responsible mobile device usage. This topic is within the confines of the LO class.

7.1.2 Mobile Phone Capabilities

At the start, the Planning Team considered the results of the Mobile Device Survey which is presented fully in Appendix B. Below is the summary of the mobile phone capabilities from the Survey (sample size 257 students):

Table 7.1: Summary of the mobile phone capabilities from the Mobile Device Survey (sample size 257 students)

Capability	Yes (%)	No (%)	Unsure (%)
Voice Call	100.0	0.0	0.0
SMS Capability	100.0	0.0	0.0
Play sound clips	74.7	21.4	3.9
Play videos	35.0	35.8	29.2
Run MXiT	99.2	7.8	0.0
Access the web	26.1	55.6	18.3
Has Bluetooth functionality	57.6	26.1	16.3
Has Wi-Fi functionality	6.2	86.7	7.0
Has 3G capability	10.5	80.5	8.9
Has still camera	44.4	55.6	0.0
Has video camera	37.7	55.3	7.0

The content which was to be delivered was text-based so the Planning Team felt that SMS and MXiT media (bold-faced in the table above) would be a suitable starting point as almost all phones used by students had those capabilities. Other media capable of delivery text-based content such as mobile web could potentially be used in the future and thus were also considered. The Planning Team decided to first look into the use of MXiT as it is the most versatile and the students were more inclined to make use of it because of the lower cost.

MXiT is a popular South African-based chat service with clients available for the majority of the mobile phones in used in South Africa. The service is very popular

with children as it uses the mobile company's data services to send and receive messages, resulting in far less cost than with SMSs.

7.2 Iteration S1

Activity Reference: #STF05

In this iteration, which happened after the interface and backend's first iteration (T1) had started, we were still unclear on the content (and its format) that was to be delivered over the MXiT medium. In addition to this, the students interviewed and surveyed considered the delivery of other types of content worth exploring, despite how teachers might feel. For example, in the Survey, the majority of teachers felt indifferent about delivering notes (57.8% - Survey question 20T1.3) while the majority of the students (86.8% - Survey question 20S3) thought that it would be useful or very useful. A similar disagreement also occurred with providing help over the mobile medium with 60.9% of teachers saying that it would be somewhat useless (Survey question 20T1.4) and 92.2% of students saying that it would be useful or very useful (Survey question 20S4).

It was felt by the students that notes delivery over the MXiT medium was worth exploring even if it may eventually not make it into the system due to the absence of the information itself coming in from the teachers. Should the delivery of such information prove to be popular with students, it was thought by the students that the teachers could then be convinced of making it available to students in future iterations of the program. The Planning Team considered this and agreed that other content types were worth exploring and that the opportunity should be opened to teachers to volunteer to provide the necessary content.

From a content point of view, some content such as notes formed a more desirable option to test the medium than the reminders. Since at that stage, there was no way of retrieving the reminder information in real time and delivering it to students in any case. Having desirable content that could then be deployed to more students allowed us to work on how to best make use of the medium to deliver information while waiting for the development of the interface to get the reminders from the teachers.

7.2.1 Goals for Iteration S1

Activity Reference: #STF04, #STF05

Although the main goal of this iteration was to explore the use of MXiT in providing content to students' mobile phones, there were a number of challenges that needed to be overcome in order to do this:

1. What content will be delivered and how can this be done over what is essentially a chat-based medium?
2. How will the authentication of the user be achieved by the system?
3. How to test the system with a wide audience and how to receive feedback from the users?
4. How can IT students be involved with the programming of the system to deliver content via MXiT?

The Planning Team considered each of these aspects initially.

Delivery using the Chat-based Interface

Consultation with students revealed that MXiT, at this stage, was already providing an interactive service based on *bots* - interactive computer programs that act like a chat contact. The services were used to deliver help on how to use MXiT and had grown into delivering other information including advertisement and marketing material by companies targeting the youth market.

Authentication

Analysis of the MXiT protocol revealed that each MXiT user is identified either by

- their mobile phone number if they have not chosen to hide it or
- a unique ID if they have chosen to hide their phone number

This meant that a way had to be found to match up these IDs and phone numbers with the actual students. If this could be done, then we could make use of these to identify the students. This would be important later on to deliver the correct homework information to the requested students. We discovered early on that even

though the school did have accurate records of the students' phone numbers, some students were making use of a different number for MXiT. In any case, asking students for their MXiT ID would not work as there was no way for students to retrieve this information from their phone as MXiT application was matching up the phone number to an ID on their server during the log on process.

Content

The Planning Team decided, with students' input, to explore other content that would be delivered on MXiT in the iteration S1. The purpose was to mainly test the medium's effectiveness in the delivery of content and our authentication solution. The result relating to the popularity of the content would be considered at a later stage but the content to be delivered, at least in the next few iterations, would be the reminders that were being worked on in parallel in the T-Iterations.

Receiving Feedback

The *bot* itself could act as a way to receive feedback from the students. They could choose a menu item that would allow them to leave any feedback. The system also kept a log of the frequency of access.

IT Student's involvement

Students' programming abilities needed to be assessed. This was done by curriculum-aligned tasks which could be set to involve the use of MXiT. The IT teacher in this case was the best person to create such tasks and subsequent assessments. After appropriate assessments had been conducted, we had a better idea of how much involvement the students could have in this aspect of the project.

7.2.2 Design of Iteration S1

Activity Reference: #STD04, STD05

Once again the Process approach was followed and an important aspect of this is the internalisation of the design process to resources available within the school. This was done in the following ways:

7.2.2.1 Authentication

To allow participation from students in the design process, the IT Grade 11 class had, as part of their lesson, a discussion on how to solve the authentication issues. They were given the following scenario:

You are creating a bot on MXiT that will provide a service to students to get their homework and other class related information. To do this, the bot needs to match up the MXiT ID sent by MXiT with the student's actual name so it can find the correct homework for that student. Note that this only needs to be done once during first contact.

You have been asked to provide a viable solution for this problem.

Remember that the name you retrieve from MXiT cannot be assumed to be correct because the user may not have signed up with their real name. Neither can it be assumed to be unique. Only the MXiT ID is guaranteed to be unique.

This was then followed up by a typed-up assignment which asked for the solution to be submitted in the form of either a flow chart or a bulleted description of the process.

One of the proposed solutions which eventually got implemented works as follows:

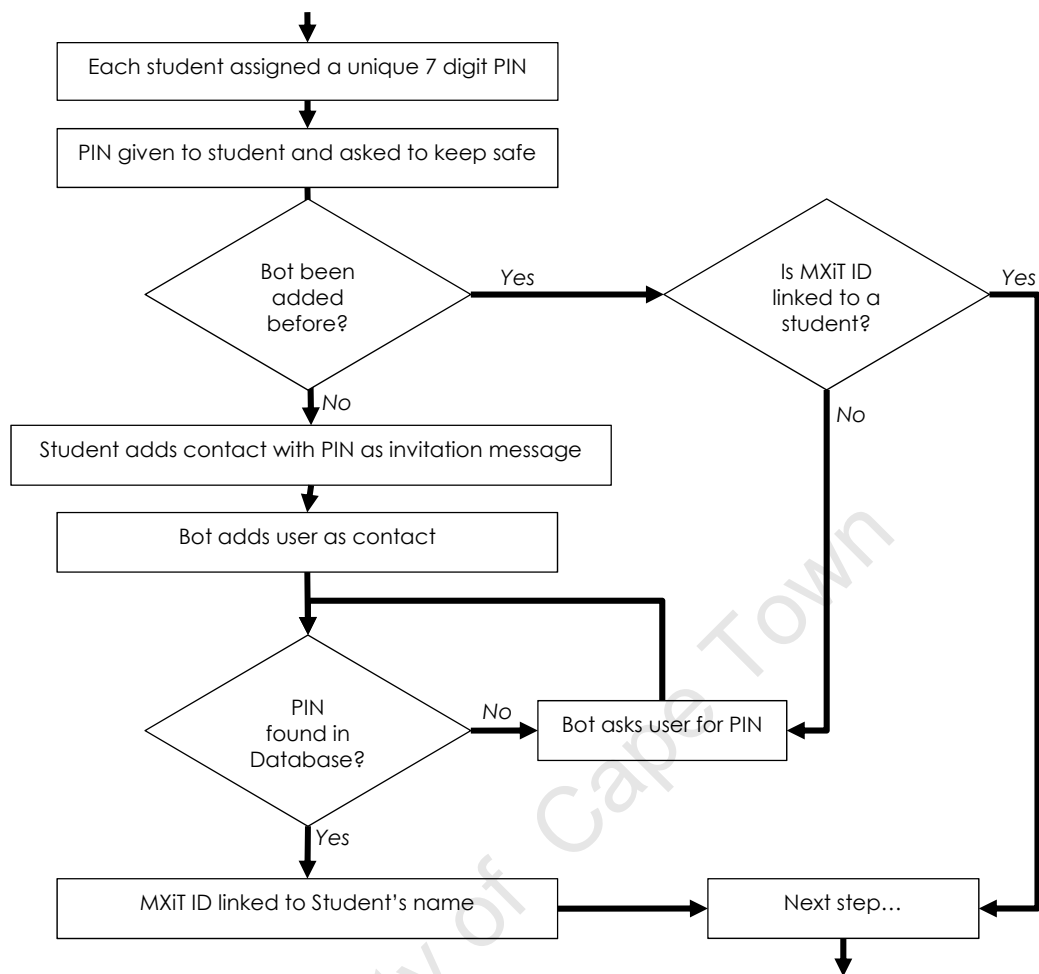


Figure 7.2: Solution that was chosen for implementation of the MXiT service authentication

7.2.2.2 Possible Services and Getting Feedback

Grade 10 IT students were asked to simulate possible interactions between the user and the bot for various activities suggested by the Survey as well as the menu system itself, in order to get feedback on this and any other activities they may think of. Here are some design examples submitted by the students. Note that MXiT supports selectable links and allows the user to navigate between them using up/down arrows on their phone. They can then 'click' on the link by pressing the action button on their phone. A link is signified below using underlining. Only some solutions are shown (mainly those that made it to iteration S1 design)

Menu System

Bot: Choose from one below:

1. Homework/Test Information

2. Notes

3. Help from teacher

4. Feedback

User: 1

Bot: Welcome to Homework..

Homework/Test information (Solution 1)

Note that homework information format is not known at this stage – these were just what the students thought would be delivered (similar to what is seen written on white boards)

Bot: Homework for tomorrow: (Click for detail)

MAT: Pg 52 – Exercise 3

IT: Prac 1.3 – Revision

See more..

User: IT

Bot: Prac 1.3 – Revision – More information on Moodle

Homework/Test information

Bot: Select Date you want to see homework

<<	<		May	>	>>
S	M	T	W	T	F S
				<u>1</u>	<u>2</u> <u>3</u>
<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u> <u>10</u>
<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	[15]	<u>16</u> <u>17</u>
<u>18</u>	<u>19</u>	<u>20</u>	<u>21</u>	<u>22</u>	<u>23</u> <u>24</u>
<u>25</u>	<u>26</u>	<u>27</u>	<u>28</u>	<u>29</u>	<u>30</u> <u>31</u>

Or Go to TODAY

User: TODAY

Bot: Homework for 15 May 2009

MAT: Pg 52 – Exercise 3

IT: Prac 1.3 - Revision

Back

Notes

Bot: Select subject: Maths, IT

User: IT

Bot: Select Topic:

1. Hardware

2. Software

User: 1

Bot: Hardware is the physical components of a computer. "Hard" in the sense that it cannot be easily modified/changed (only replaced). Most of the hardware is never seen by computer users

Back Next

Multiple choice questions

Bot: Select subject: Maths, IT

User: IT

Bot: Select Topic:

1. Hardware

2. Software

User: 1

Bot: What part of the computer does the processing?

A. RAM

B. CPU

C. CMOS

D. BIOS

User: B

Bot: That is correct.

Ask Another or Quit

Help from teachers

Note that there is a problem with this design. There is no way to for the user to leave the chat.

Bot: Current Teachers online - click to chat

1. Mr Jak

User: 1

Bot: Now chatting to Mr Jak

User: Hello Mr Jak

Bot: Mr Jak: Hello Jim

Feedback

Bot: Type me any message to send back to the Team.

User: Keep up the good work

Bot: Send another?

Yes / No

Other ideas suggested were

- Access to past examination questions
- Wikipedia
- Equation solver

7.2.2.3 MXiT Programming Exposure

Students also got a feel for designing a MXiT bot by creating a simple calculator bot that can do simple arithmetic for them. As part of the curriculum students already learnt basic commands in Java to acquire input from the user and to output a message. The most used commands for doing this were:

```
BufferedReader in = new BufferedReader(new InputStreamReader(System.in));
System.out.println("What is your name?");
String userName = in.readLine();
System.out.println("Hello " + username);
```


As a result, IT students are already quite familiar with creating dialog type interface for computer screens. In an effort to make it more appealing to students, a library to connect to MXiT was created to reflect similar programming constructs. This allowed students to create a MXiT bot with similar commands:

```
MXiTBot bot = new MXiTBot("0750005000", "12345");
                        // Login ID , password
bot.println("What is your name?");
String userName = bot.readLine();
bot.println("Hello " + username);
```

The bot also allowed for creation of MXiT hyperlinks¹⁴ using simple HTML <a> tag with the linked word in the target. Grade 10 IT students were familiar with this command as they have worked on a simple HTML-based web page creation module. Here is an example:

```
MXiTBot bot = new MXiTBot("0750005000", "Open123");
bot.println("Which game would you like to play?");
bot.println("<a href='Hangman'>1. Play Hangman</a>");
bot.println("<a href='Guessing Game'>2. Play Guessing Game</a>");
String userResponse = bot.readLine();
if (userResponse.equals("Hangman"))
{
    startHangman();
}
else if (userResponse.equals("GuessingGame"))
{
    startGuessingGame();
}
```

The MXiT bot library allowed students to learn basic programming constructs such as selection and loops in a way that allowed them to show off their programs to their friends and family. From the point of view of learning to program this was a huge incentive for students to want to do 'boring programs' that asks the user for input and to process their response in some way.

¹⁴ This is a word or phrase that the user can select which will result in the *linked word* being inserted into the conversation. For example, 1. Play Hangman could be linked up with word *Hangman* so that when the user select this link, the word *Hangman* is then inserted into the conversation.

Grade 11 students who were more advanced in programming in Java were set exercises such as the MXiT calculator. The MXiT library was subsequently used by these students to explore different services that could be created. A six week project was then given to students requiring them to consult with teachers in the school and to come up with different ideas that would be useful to their teaching. They attempted to code the idea and working results were then tested with their peers and feedback received. This project was aligned with the assessment requirement of the Department of Education and thus their assessment rubrics could be used to measure the result. This also helped the students to be familiar with the MXiT library code.

7.2.3 Detail of the Implementation

Activity Reference: #STD05

The system used in iteration S1 was implemented entirely in Java. The Java library allowed for the creation of the MXiT bot that then connects to the MXiT server via the Internet using the MXiT protocol. The MXiT bot essentially appears to other user as a client and other users are able to add it and chat to it. Students created the bot and interacted with it in the same way they would with a command-line-based (console) Java program. The difference would be that the testing could be done on their mobile phones. Students were also able to leave the bot running overnight and ask their friends to add the bot.

All data used in each bot are stored in files on multiple lines separated by specific tokens chosen by the students. The reason for using this method is that file reading and writing are done in this way in the IT curriculum (South African Department of Education, 2008). The students were familiar with the operations.

Here is more detail about each service.

7.2.3.1 Notes

On accessing this service, the user was presented with further menu options to select the subject and topic. Once this was chosen, two modes of notes (if both are available for that content) are then offered – hierarchical (book-like) structure or

short snippets (flatten structure). If the content was only available in one mode then there was only one option shown. On selecting either choice, short text of the chosen content was sent one snippet at a time back to the user. Sending a blank message or selecting the *next* menu (which is automatically highlighted at the end of each line) would trigger the sending of the next line. Teachers provided the content by providing a file containing the information with tabs to indicate hierarchical structure (for the hierarchical mode) or just plain text file with each snippet on each line. There was also an option to treat hierarchically structured files as snippets.

Here is an example of such a text file. Only the first few lines are shown. In this example, each line represents a chunk of information. Only one chunk was sent at a time. Chapters were separated by a blank line. The first line of each chapter was the name of the chapter. The name of the file is the name of the topic. Sample data from a file called 'algebra introduction.txt' is shown below. Note that line numbers were not present in the text file – they are only provided here so that the line separation can be seen. Students were also free to choose any formatting they want. This is just one of the examples as chosen by a student.

1. Algebra Introduction
2. Algebra was designed to solve a type of mathematical problems.
3. It involves working with unknown values (variables).
4. A variable is usually represent by a letter of alphabet, usually x.
5. An important concept is algebra involves equations - You can think of an equation as a balance scale.
6. An equation must have an equal sign. Each side of the balance corresponds to each side of the equal sign.
7. ...

7.2.3.2 Multiple Choice Questions

On accessing this service, the user was presented with a list of available multiple-choice questions. Two modes were created. In one mode, all the questions were sent to the user one at a time, without any feedback information. The score was tallied up and presented to students at the end. In another mode, feedback on the choice selected by the student on why the answer was correct or incorrect as well as some additional information were provided back to the student. The student then had a

choice of whether to retry the question or move on. The teacher provided relevant and helpful information for each choice.

For data storage, each question, the possible answers, each answer's feedback and the correct answer were stored entirely in one line. The four components were separated by #'s. The order was the question, followed by possible answers, each answer's feedback and the correct choice (starting from 1). The answers and feedback were further separated by /'s. The name of the file indicates the topic. Here is an example of one line from the file called 'computer studies past multiple choice questions.txt'. The one line stores all the relevant data for one question.

```
A cluster is#a collection of cylinders./the usual target for viruses such
as trojans./ the smallest addressable unit on a hard disk./the name of a
single block of data on magnetic tape.#This is not correct./Viruses target
many different parts of the system - usually a loophole in the operating
system or other software./A cluster is a group of sectors of a hard drive.
However, to keep the management overhead down, the cluster is the smallest
addressable unit (not the sector). This means that there are less numbers
of cluster to manage, but it also means that anything smaller than a
cluster is essentially wasting space./This is incorrect. A block of data
on magnetic tape is called a ...er block!#2
```

7.2.3.3 Past Papers

Students were presented with the past examination paper (by year) to choose from. On selection, each question was provided with a choice of seeing the answer at the end of each question. Teacher may choose for the answers not to be available. The basis for this service was exactly the same as for notes. Answers to the question and feedback, if made available by teachers, were given in even-numbered lines while the questions themselves were in the odd-numbered lines.

7.2.4 Reflection from Iteration S1

Activity Reference: #STD04, #STD07

- Authentication worked well on paper but without actually using it they would never know if it works.

- Bots that were written up worked well, but there was no record of what was being accessed only what comments they chose to leave behind. The feedback from students was that they and their friends found the system useful. Parents that were shown the system by their children commented (via e-mail to the IT teacher) that this would be useful as they cannot get their children off the system anyway so they may as well get them to do something useful with it.
- It was difficult to assess reminder bot as there was no incoming information. However, students had a good discussion on what they would like to see once a day. Should it be all the work given out today or should it be all the work that is due for the next day (and hence they should make sure they do it today). In the end, the students had agreed on the latter set up of displaying the work that is due on the selected day. This also made sense for tests as it is more useful to show when the test is and not when it was given out or mentioned.
- External students outside of the school also left comments saying that they would also like to have access to the system as well. They had known about the system from their friends who attended the participating school.
- A more accurate way to test if MXiT notes and multiple choice question bots were working and how they affect learning – if any – was needed.
- **Other access methods:** Students pointed out that other access methods should be provided. SMS for example, would allow all students to receive the information and web-based access is also on the increase.

With respect to the goals for this iteration S1:

1. We had determined that a chat-based system can be used to deliver different types of content over the mobile medium.
2. We also worked on the authentication system, but were not able to implement and test the system.
3. Student-implemented bots were tested by the students themselves and their friends both in and out of the school.
4. We have involved IT students in the majority of our activity in this iteration.

7.3 Iteration S2

Activity Reference: #STF08

Chronologically, the second iteration (S2) of the student-based part of the system started after the third iteration of the teachers' part of the system. At that stage, we already had the PHP-based EIS system generating forms to be filled in by the teachers. The system also outputs information on homework and tests on the current date on the form printed for the teacher each day. The same system was also being used by students to capture those data during the homework period. EIS also contains information about the different classes (location, which teacher and which students are in the class).

7.3.1 Goals for Iteration S2

Activity Reference: #STF08, #STF12, #STD15

The goals for iteration S2 were as follows:

1. More accurate evaluation of notes and multiple-choice services on MXiT.
2. Link up EIS so that reminders can be provided to students over MXiT.
3. Explore the use of SMS and web-based delivery media.

7.3.2 Evaluation of Notes and Multiple Choice Services

Activity Reference: #STF08, #STF10

Testing was done over a period of six weeks at the participating school. Content was provided in the subject of Information Technology, Mathematics and Physical Science. Students taking these subjects were informed of the MXiT ID number for the service and were able to add this contact to their MXiT chat profile allowing them access to the content. The test was conducted independently of the EIS system and other projects that were being done at the same time.

In the study, students made use of the services in their own time. All in all, 25 students took part (12 did Information Technology, 16 did Mathematics and 10 did Physical Science – there were overlaps as some students did more than one subject).

Eight external students (who did not attend the participating school) also requested to make use of the system. They knew about the evaluation through their friends who were taking part. Three teachers also participated in the study.

7.3.2.1 Data Collection and Relevant Results

Data were collected as follows:

- **Electronically:** The server logged all requests and replies including the user information and time of access. There was also a service whereby students could leave comments and messages on the service. All of the students accessed the bots several times each day with the number peaking just before the test for IT students. Positive comments were left, specifically messages that they find the service useful and requests for more content to be put on the system. External students also commented that they would like their own school to implement a similar system.
- In a theory test assessing the topic of Computer Networks, 20 marks worth of recall questions were included. Of the 20 marks, 10 marks' worth of content was available on MXiT while the rest were available on printed and other electronic media (Slideshows). The results were captured to compare the use of MXiT versus other media. The students were also interviewed after the test. In that test, students scored significantly better in questions¹⁵ based on content available on MXiT than questions whose content was not (7.46/10 versus 4.07/10). Afterwards 10 of the 12 students confirmed that they only studied using content from MXiT. However, this result cannot be used on its own to show that MXiT produces a better result because the difference could be due to:
 - The difficulty level of the two groups of questions may be different.
 - Some of the students may not have known the content that was not available on MXiT well. That is why those questions may have been badly answered.

¹⁵ In a theory test assessing the topic of Computer Networks, 20 marks worth of recall questions were included. Of the 20 marks, 10 marks worth of content was available on MXiT while the rest were available on the slide shows.

- The ten students who only studied from MXiT-based content may only have done so because of convenience. The MXiT system may not necessarily be a better medium of learning – just a more accessible one at the time.
- **Post-test comments:** Eight of the participating students were also interviewed on the use of MXiT to deliver content. Students confirmed during the interviews that they found MXiT more convenient to access information from. They also found that they would use it during their spare time to read a few lines at a time or try a multiple-choice question or two. Some felt that this was due to the novelty factor which may wear off in time and become just another medium to access academic work.
- **Interviews:** The teachers involved were also interviewed and they indicated that students were telling them that they were going over the work more. They also reported students asking for more content to be put on to the system. All three teachers also felt that the students are perhaps looking at the content because of convenience and/or novelty and that this may only be a temporary effect.

7.3.3 Towards SMS and Web-based Services

Activity Reference: #STF09

The Planning Team explored the use of SMS, taking into consideration the reflection from the previous iterations. It was suggested previously that reminders of homework and tests being input into EIS could be sent via SMS.

There were two problems associated with SMS. Firstly, there was a high cost associated with SMS. It costs the school 23 South African cents per SMS (reduced rate for school with the exchange rate of about R8.50 to US\$1 in 2012). For 250 students, this cost the school almost R115 to send a reminder to each student and one of his/her parents. A possible solution to this problem is to use premium rated short code which charges the user more than the standard SMS (R1 instead of the

usual rate of between 35 and 85 cents) but the service allowed the receiver to reply at no cost. The service required the use of HTTP-based protocol to connect to it.

The second issue was the content type that can be delivered as well as the format. Out of the content that has been explored so far, the notes and the multiple choice services would consist of too many messages for affordable usage. Only the reminders were deemed to be a viable option for further exploration.

Web-based access to the reminders was already available as EIS was able to output the information in HTML (the form generation is done in HTML over the school intranet). There was, however, a need to investigate how this content can be formatted for delivery over the web and on a mobile phone screen.

7.3.4 Modification to the EIS server

Activity Reference: #STD13

EIS was essentially a web server and it already contained information about classes, teachers, students as well as the homework and test information inputted by the teachers. It made sense to expand on its service to cover the goals of iteration S2 as follows:

1. The login system planned for iteration T4 for the teachers' interface can also include students. This would enable web-based authentication without any additional work as both students and staff information is already on EIS. Since the authentication service was provided via HTTP, it made sense for the Java-based MXiT bots to make use of this instead of recoding the code in PHP. However, the authentication system was not available during this iteration.
2. Java runs much slower than PHP does. While this was fine for use with the MXiT bot because there was high latency involved in sending message to a mobile phone – it would be far too slow for a web-based service to make use of the bot written in Java for notes and multiple choice questions. However, Java and PHP are very similar so that porting of code from Java to PHP was done by a final year IT student with some PHP training.

3. Premium rated SMS service made use of HTTP – EIS server was modified to receive service request made via a short code and to send a reply back to the service provider to be forwarded back to the sender.

7.3.5 Towards Homework Information via the Mobile Web and SMS

Activity Reference: #STF09

Our initial interview into how students kept their homework diary indicated that students wrote down homework in the space for the current day while some also wrote down the same information on the due date. The group of IT students working on the design of the reminder bot also thought that it was more useful to show the work due for the selected date instead of the work given out on the selected date. The group decided that when a date is selected the system would give the user a choice of either all the work due for the selected date or all of the work given that day. However, delivery of content via the web meant a redesign of the website as EIS was only able to output in the same format as the forms the teachers use to see what they have inputted previously. It was decided that this output interface would also be tested by volunteer students.

The SMS system was not implemented in this iteration because the school had not approved the signing up of the premium rated SMS service. There was an associated cost of R750 per annum. It was hoped that this would be approved in time for the next iteration. Students would be consulted on whether or not they would make use of the premium rated SMS service to receive SMS since there was an associated per message cost.

7.3.6 Testing of the reminder system via MXiT and web

Activity Reference: #STF11, #STF12, #STD15

At that stage, the EIS system still did not have authentication but the reminder system was hard coded for the ten students who volunteered to test the system. They were not IT students nor were they involved with the capturing of the homework.

The participants needed to perform the MXiT linking process outlined in the iteration S1 using the username and password given. Once this was done, the student's MXiT was added to the reminder bot's MXiT account. The system had information about the classes of each of the participant. These hardcoded links still allowed the students to access the homework information entered by their teachers over MXiT and the mobile web. The web-based system was also similarly hardcoded with a temporary username and password linking them to their correct classes and homework. Using the calendar interface, students were able to access the homework due for the next day (i.e. work they should make sure they finished today) as well as the work given out today.

The students had access to the system for 3 weeks of testing. This three-week period included the run up period to the mid-year examinations. Data was collected by usage logging and with reflection sessions afterwards.

7.3.7 Reflection from Iteration S2

Activity Reference: #STF14, #STF15

- Students ended up using both mobile web and MXiT systems as they were under the impression that they needed to do both. They did this despite not being asked explicitly to do so. When asked about this, they said that they thought that was the point since they were given information on how to access both of these media.
- Students liked the fact that there was no logging in with MXiT – the relevant data is already there. They disliked having to log in on the web interface on their mobile phone even though some did eventually save their login

information to the browser. Some students also reported that the calendar, displayed on both MXiT and the web on their phone, did not fit across the screen and this meant that the calendar looked all jumbled up.

- Some students accessed the system from their desktop and this worked well.
- Students showed preferences for seeing the work due for the selected day. Some students expressed annoyance at being asked to choose between work due and work given out. Some of these students said that the work due for today should just be displayed without any date being chosen.
- Students indicated that not all teachers were entering information.
- Some students forgot their password and there was then no way to retrieve or reset their password. One student changed his mobile phone number but he could carry on using his old MXiT detail on the new phone. However, this raised the possibility that a student may want to change to a new MXiT login for whatever reason. This was also not possible to do at this stage.
- Students also complained that the design of the site looked bland and should be changed.

7.4 Iteration S3

7.4.1 Changes in iteration S3

7.4.1.1 Website and Mobile Website Redesign

Activity Reference: #STF17, #STD23, #STD26

As the website and the mobile website needed to be redesigned to look less like paper form, the design teacher proposed the involvement of her classes. Design students were shown the initial design of the various pages on the site and the information that must be shown. They were then given a brief to replace those pages with their own design for both desktop and mobile versions. They must take into account various design aspects outlined by their teacher. Two members of the IT Club were also part of the Design classes and were able to give some technical information to fellow students when required.

This exercise culminated in a demo and display session of each student's redesign. Some of the students were able to recreate their design in HTML with the help of the IT club members present, while some showed static mock up.

The class had a discussion after the session and positive aspects of various designs were selected by the students and design teacher. The design teacher then worked on combining these aspects and presented them to the Planning Team.

7.4.1.2 Technical modifications

Activity Reference: #STF19, #STD25

In addition to the design changes the IT club members were able to make to the students' interface, the following changes were made to address issues pointed out in the previous iteration:

- The web system has the option of remembering who the student is after first log-in. This was done via a cookie.
- The calendar was removed from both MXiT and the web interface. Instead a "see more" link was added at the end. Selecting the link will cause the system to display more information on work due further into the future. The increasing ranges were next day, next week and next 2 weeks. This also necessitated the display of the due date which appears first and is then followed by the items due for that date. There was no option to see work given out on the selected date. Here is an example of what a student would see when chatting to the reminder bot.

Homework/Test information

Bot: Due today (15 May)
 - MAT: Pg 52 - Exercise 3
 - IT: Prac 1.3 - Revision
 .. See more

User: more

Bot: Due today (15 May)
 - MAT: Pg 52 - Exercise 3
 - IT: Prac 1.3 - Revision
 Due tmrw (16 May)
 - PHY: Test on Newton's law
 .. See more

7.4.1.3 SMS Interface

Activity Reference: #STD20

There was enough interest by students wanting to use the premium rated SMS service – mainly for test information (as there were fewer tests than homework). To enable this, the system was set up in such a way that students were able to send an SMS to a premium rated number and receive a reply on what was requested. Possible request for homework could be done by sending an SMS with keyword 'Homework' sent to the premium-rated number (PRN). Test and examination information could be similarly requested by sending the keyword 'Test' or 'Exam' respectively to the PRN. The reply would contain as many events as possible in one standard-size SMS in the order of the work that was due the soonest. We made use of an external service provider to provide us with PRN. When the service provider received a PRN request from a number, it forwarded the content to our server where the mobile number making the request is matched up to a student in the school database (which contained mobile numbers of all students). We then used this information to reply with the homework for the student.

If the mobile phone number was not recognized by the system, a reply was sent back asking the student to come in to the reception to add this number to their file at school. Once the profile is updated, the student is able to make use of the PRN service.

We also resolved the password reset issue using SMS PRN. Students can send a password reset request to the PRN (Keyword 'Password Reset'). The password will then be changed and sent back to the student's cellphone number.

7.4.2 Participants and Duration

Activity Reference: #STD25, #STD28, #STF20, #STF21, #MTM02

User names and passwords were created and distributed for every student in the school via their mentors. The slip contained information about how to access the web-based and MXiT based services as well as the SMS PRN service. The original intention was to run the system for six weeks, then have reflection sessions with those involved. However, this timeframe was affected by the slow uptake and the subsequent intervention.

7.4.3 Slow Uptake and Competition

7.4.3.1 Slow Uptake

Activity Reference: #STF22

About a week into the study, the Planning Team held a review meeting to discuss the progress. The following observations were made:

- 42% of the students had logged into either the web or MXiT and no one had made use of the SMS service.
- Those that have logged on were not checking in every day.
- Some of the teachers present reported that some of their students were not sure of how to log in and that some of them have said that not all of the teachers were entering the homework information. Some had said that the system would be pointless without more teachers entering the information.

This was backed up by inspection of the data added by the teachers. There was an average input rate of 65%. This number was too low even when we took into account that some subjects may not be giving out homework every day.

7.4.3.1 Modification to address these concerns

Activity Reference: #STF22, #STD29, #STF23, #STD30

To resolve these issues, a competition was proposed by the Planning Team. Points were given for various activities and the student with the most points would win a prize (an iPod Shuffle).

Points are given as follows:

- Viewing any homework or test information for the first time: 5 points (Points are only given for the first time on any method – so accessing the same homework again on a different method does not get the student the points again).
- Helping a student to log in (provided the student who logged in for the first time mentions the helper's name) : 25 points

It was hoped that giving points to a view action would encourage students to not only view the information more often but to also for them to encourage their teachers to enter more data into the system (so that the students could get points for seeing it). If a student had a teacher who was not interested in entering data into the system, their chances of winning the competition would be reduced by one seventh (each student does seven subjects).

It was hoped that the referral system would encourage students who were already on the system to help others to log in in order to get points for it.

The system was modified to keep track of the points and to display this information on logging in. The system also told them their current position and the points for the position that was just higher than them. It was hoped that this would encourage further competition amongst the students (as well as the side effect of getting the teachers to enter more data).

It was decided that the competition would run until the end of the term. This was about three weeks longer than the original six weeks duration. This meant the study ran for the entire term.

7.4.4 Reflection

Activity Reference: #STD20, #STF22, #STF23, #STF24, #STF25, #MTM03

Feedback was received in a number of ways

- Students who helped with the redesign of the reminder bot and the login were involved in their own reflection session.
- Students' feedback received by the system was also looked at.
- Students were interviewed across the different profiles by their mentors. They were separate into those who made use of the system regularly to those who hardly used the system. Interviews happened throughout the term. 45 students were interviewed for feedback in total. The mentor then summarised the result and forwarded them through the relevant grade heads who then forwarded to the feedback to the Planning Team.
- Log information from the EIS server was also examined.

Relevant observations and feedback received were:

- The students on the system (across all services) increased to 80% in the week after the competition was announced.
- Also within the same week, the usage also shot up with 63% of the students who signed up accessing every piece of homework or test information every day. 95% of those who signed up logged in at least once a day. This level was sustained throughout the competition.
- Teachers also reported students asking them to add the same homework every day until the due date – even though this was not necessary. Some of them have actually asked for more homework.
- Teachers' input rate also increased to a high of 90% on some days. The average daily rate was 82.5% up from 65.2% before the competition was introduced.

- Only 17 SMS requests were received and only by two students. Efforts were made to track them and query why they are making use of the SMS service instead of the others. It turned out that they had not managed to get either MXiT or mobile web working on their phone. IT Club students helped them to set up MXiT on their phone and they did not make use of the SMS service further.
- All students interviewed found the reminder service useful – even those who were making very little use of it. Discussion with the teachers indicated that those students were not doing very well in class and that they were not doing any work anyway. The issues were probably more complex than just not remembering when to do work. For example, one of the students was on a drug rehabilitation programme and the other was very weak academically.
- An interesting case is when a parent actually used the system to track her child's work and making sure that he was doing the work. The student himself was not interested in accessing the information. We only discovered this because the parent had left feedback on the system indicating this.
- Suggestions were made for the information to be provided over the Blackberry Messenger (BBM) Service.

At this stage we arrive at the conclusion of both the T-Iterations and S-Iterations. In the next chapter, we will look back at our integration experience with the intention of answering the two research questions posed earlier.

University of Cape Town

8

Answers to the Research Questions

In this chapter we consider the two research questions proposed in Chapter 4 and answer them using what we discovered during the application of our combinational PEAR approach outlined in the last two chapters. We also present the result of the survey conducted by the school into various aspects of the implemented system and the integration process itself.

8.1 Source of the Data

In addition to data collected in the teachers- and the students-based integration processes outline in Chapters 6 and 7, the school also conducted separate surveys. The school administered all of the surveys and captured the results as part of the standard feedback process. The questions came from the Planning Team and were sometimes included with other questions included for other purposes which had nothing to do with our study at all. Data was captured by the school's administrative non-teaching staff, who also removed any names from surveys that require anonymity. Only relevant data were given to interested parties. As a result we only received data relevant to our questions. The surveys conducted were:

- **Post-implementation anonymous survey** (See Appendix C – Survey STF1) was conducted to discover issues experienced by teachers and students after the system has been running for a term. This corresponds to the end of iterations T4 and S3. The teachers were given the option of not providing their name. The purpose of the survey was to discover issues experienced by teachers after EIS had been running for a term. The teachers were also informed that the result of the survey would be used to improve the system for the next term.

- **Academic year review anonymous survey** (The questions are contained in Appendix C – Surveys STF2 for staff and STD1 for students) was conducted to determine the usefulness and user friendliness of the EIS system after being in use for the term. The result was used by the school to determine if the system should be continued to be used the following term and how the system could be improved should it be continued. The participating school conducts this survey annually with teachers and students on various aspects and activities at the school. Examples include students' rating of each of their teachers in terms of lesson delivery, ability to inspire and ability to explain amongst others. Teachers were also given the opportunity to evaluate various systems and structures in place. Survey participants were encouraged by the school to complete the survey honestly. EIS evaluation questions were included in this survey. Staff and students completed separate surveys.

- **Problem discovery survey** (Survey STF3 in Appendix C): This survey was conducted at the start of the second term of deployment of EIS to ensure that all data on the system was accurate and that all teachers were able to make use of the system. The survey was not conducted anonymously as it was important to know who the teachers were in order to correct any issues raised.

8.2 Question 1 – Is it better and/or more successful?

Does this combinational PEAR approach result in a '*better*' or more '*successful*' integration of a medium into education?

This question was evaluated in two ways – by the participants of the study; and by comparing our integration experience to those identified as ICT4D and past integration challenges (Table 3.1).

8.2.1 Internal evaluation by participants and users

8.2.1.1 *Is It Useful?*

The teachers and students were asked directly on the usefulness of the EIS reminder service introduced (STF1/Q1 for teachers and STD1/Q2). 96% of the teachers and 78% of the students who used the system, rated the system either 4 (useful) or 5 (very useful). Although this was very subjective and not easily comparable with past integration experiences, it nevertheless did show that the service was considered useful by most of its user. This is important, as a successful integration process could not be considered a success if the service it is trying to introduce over that medium is not useful.

8.2.1.2 *Was the Integration Process better?*

The teachers were also asked how the introduction of the EIS reminder service went in comparison to their past ICT introduction (STF1/Q7). 96% of the teachers rated the system as better (52%) or much better (44%). One teacher indicated that the experience was the same. The question of whether or not an ICT introduction process is considered better or a success is very subjective and was relative to each teacher's own individual past experiences with integration but this was an indication that the majority of the teachers were positive about how the service was introduced.

8.2.2 Comparison to ICT4D and Past Integration Challenges

In Chapter 3, we motivated that the challenges experienced in ICT4D were very similar to challenges experienced by

- our participating schools in the Preliminary Study. These schools were well-resourced – relative to other schools in South Africa
- the Khanya project, whose aim was to integrate ICT equipment into state schools in the Western Cape. The participating schools in this project ranged across the five quintiles from the most poor to the least.

We revisited these challenges and discussed how our combinational PEAR approach affected them. For each of the ICT4D challenges discussed in Chapter 3, we provide a summary of the challenges experienced by the participating schools in our Preliminary Study as well as those experienced by the Khanya Project; followed by a discussion on the effects of our PEAR approach on that challenge.

8.2.2.1 Lack of infrastructure such as ICT equipment, electricity, Internet

Connectivity and high cost of implementation and maintenance

Table 3.1a: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Even in well-resourced school, ICT equipment is not a priority. Reliable electricity provision and affordable Internet connectivity are still issues in South Africa. Schools do not have financial resources to justify the budget necessary for implementation and upkeep of equipment and/or system	Lack of equipment and infrastructure was one of the many challenges that needed to be overcome by the Khanya project. In 2010, Khanya was still experiencing these issues in all schools they were involved in.

Our experience:

- Use of existing equipment already present in school for the teaching of various subjects meant that there was no new cost associated with this. Equipment due for disposal was kept and optimised for use so as to provide web-based interface for entering homework and test information.
- Once a usage case had been proven useful, the school was more willing to budget for more suitable equipment. For example, the above-mentioned computers were slowly upgraded first with more RAM, then a flat screen monitor, then totally different computer all together. Once the school management saw their usefulness, upgrades and replacement were budgeted and purchased.
- Internet connectivity for the servers was and still is piggybacked onto the school's existing services. The students and staff normally access the Internet during lesson time while services such as homework information provision

via the web and MXiT were used in between classes and after hours. The minimal chance of overlap in usage time was the initial motivation for the use of the existing Internet connectivity. The additional usage level was monitored and once it was proved to be minimal, the school approved the continuation of usage of the existing infrastructure.

8.2.2.2 High cost and/or lack of qualified personnel for implementation, training, usage and support

Table 3.1b: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Schools do not have dedicated personnel and often have to hire external expert at high cost in order to implement and support the technology.	Lack of qualified staff in the Western Cape schools was one of the many challenges that needed to be overcome by the Khanya project. Cheaper support methods (cascade or long distance) did not work well. More costly face to face method was found to be more effective.

Our Experience:

- Teachers and students were involved in the design, implementation and support of the system as follows:
 - Teachers (Form Design Team) designed the form first on paper. The paper-based form was then translated into a HTML form by IT students. The database and the programming of the back-end server were also done with the help of students.
 - As teachers start to use the paper-based form, they were very familiar with the forms after a few iterations.
 - Students (Volunteer students with spreadsheet skills) captured the form data into forms of their own design. A common design most suited for the job was decided upon by the students and eventually ended up being the database structure for storing the content. IT students worked on this structure as part of their assignments in order to create the database.

- Students eventually captured the data using the web-based front end. This not only helped test that the system was working, but it also allowed them to be familiar with the system and thus able to help teachers in the classroom – providing an effective way for post-implementation support.
- IT Club students helped to modify existing equipment for use in the classroom. The modification was done with input from the teachers and tested with help of Grade 10 students to ensure compliance. An imaged-based setup and spare computers allowed for the quick swapping out of broken machines.
- Students were able to help design some aspects of the system. Examples included the database structure, MXiT-based user client for students, authentication model as well as the design of the desktop and mobile websites. In all cases, the students were applying the skills they learnt in class.
- Competition encouraged students to support each other to get connected. We saw an increase from 42% to 80% after the introduction of the competition.
- In the survey (STF1/Q8 in Appendix C), 84% of the teachers said that they required no or less than expected support to make use of the system. There were also mentions of student help in the comments. Some teachers did not regard this help as IT support.
- Programming skills of the researcher were still required to either teach the students or to implement part of the system (database normalisation and PHP programming). However, the level of skill required does not exceed the qualification requirement of an Information Technology teacher and that this skill set should be present in a school offering the subject.
- There were no additional monetary cost in terms of personnel usage in the design, implementation and support of the system.

8.2.2.3 User's ICT Literacy level

Table 3.1c: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Teachers, students and other users do not possess the necessary skill to make use of the technology effectively.	Teachers lacked the skill necessary to make use of the technology with some finding basic literacy training (ICDL) to be challenging.

Our Experience:

- Even though the teachers at the school did not possess basic computer literacy training (such as ICDL), the paper-based design process incorporates what teachers are already able to do well into the system. By taking the teachers' existing skill and what they are already familiar with into account, the level of training required was reduced by the phased in introduction of the paper-based forms. In the survey (STF1/Q4), 92% of staff said that they required less than average training in order to use the system effectively.
- The design of system relied heavily on users' participation and feedback. The teachers were also able to see how their input affected the design of the system in a short amount of time. Because of this, the system was sometimes modified to fit in with the user instead of the user being trained for the system.
- In addition to the student-based support, one-to-one training and the running of the system in iteration T3 without any of the data being published offered teachers an opportunity to gain confidence in using the system.

8.2.2.4 Users do not see the purpose of project

Table 3.1d: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Technology integration projects are often pushed down from the top with little consultation with end-users.	Khanya put participation and buying from all stakeholders as important but difficult to achieved in practice.

Our Experience:

Our project consisted of not only extensive consultation but also participation of users – teachers and students. In the survey (STF1/Q5), 88% of the teachers felt they were more involved with the development of the system than expected. On the contrary, 41.3% of the students felt the same way. This could be because almost all of the teachers (except for those who joined after the different iterations) were involved in the development of the forms through to the web-based interface. Students were only involved in the form of volunteers and feedback usually via mentors. 55 different students were involved in the project from capturers, database design, MXiT programming, MXiT-based content evaluation, IT support etc – representing 23% of the student body. The higher level of involvement felt was perhaps due to the running of competition and ability to provide feedback – some of which was implemented quite quickly (e.g. addition of ladders for the competition points). Students also had a shorter participation timespan, because they and the school were not entirely comfortable with them being involved in such projects in their final year.

8.2.2.5 Relevant activities such as training must be timed according to users' availability

Table 3.1e: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Teachers, students and other users are busy with educational activities throughout the day and training (and other activities) must be customised and timed accordingly.	Khanya's effort to fit in with the teachers' schedule meant that this was not a factor. Although it was noted that in some instances, there were insufficient training time outside of class time.

Our Experience:

- There is reduced amount of training to be done since teachers were already familiar with the system.
- Teachers were able to make one-to-one appointments for training at a time suitable for them.
- In-classroom support provided by students allowed the teachers to learn how to use the system on the go.
- The phased development process and the ability for teachers to provide regular feedback to the design team on a shortfall of the currently system meant that any unintuitive or difficult-to-use interface was reduced or eliminated. In the survey, (STF1/Q2) 92% of teachers felt the system was easy to use. In comparison 77.8% of students thought the interface was easy to use over MXiT (STD1/Q3) compare to 90% for access the web on a desktop computer (STD1/Q5). Surprisingly, only 51.8% of the students thought it was easy to use the mobile web interface (STD1/Q6). Closer examination of the survey showed that relatively smaller number of students had tried to do this (56 compare to 167 who made used of MXiT). A number of students were having difficulty with getting mobile web to work and/or found entering of user name and password on the phone keyboard frustrating.

8.2.2.6 Application not user friendly in assisting teachers in the integration process.

System not relevant to the local context

Table 3.1f: Comparison of ICT4D challenges and the integration challenges experienced by the participating schools in our studies as well as those experienced by the participating schools in the Khanya Project in the Western Cape.

Integration challenges experienced by participating schools (Well-resourced schools)	Issues and Challenges experienced by the Khanya Project (Western Cape state schools)
Technologies to be integrated were often designed for another purpose. Technology does not fit well within the educational context and has to be extensively modified. Other aforementioned factors make this difficult to achieve.	Khanya's hardware was chosen specifically for the purpose of integration. However, the general scope for integration often meant that teachers were overwhelmed by what should be done with the technology. Although Khanya attempted to provide a solution designed for an educational context, some teachers felt that the solution was too general for their own use.

Our Experience:

Most of the teachers and the majority of the students felt involved in the development of system. They also found the system easy to use. This can be contributed to the phase-in introduction of system. The fact that the users participated in the design meant that teachers were already familiar with the system and that it was designed for the specific context it was deployed in.

The combination PEAR process started off with a general medium and over time focused in on specific aspect of the medium that all the users agreed would be useful. There were aspects of the medium that the students would like to see fully incorporated, but this unfortunately did not happen (the MXiT notes and multiple choice bots). Despite being proven useful by our internal study, not many teachers were interested in taking this up. Perhaps the issue was not about providing a general solution to integration nor a very specific one, but rather to provide opportunities for the user to be able to hone in on the specific but common aspect of the medium.

8.2.3 Discussion on the Answer to the First Research Question

Our survey showed that an overwhelming majority of the user base thought the services introduced by our PEAR approach were useful. Furthermore, the teachers also rated the approach we took was 'better' than the past approaches they were involved with.

We also compared our experiences with common challenges identified to be problematic in both ICT4D projects and past medium integration projects in South Africa. We presented evidence of how our PEAR approach has overcome those challenges. While this is by no means conclusive proof that the PEAR approach guarantees success – it does suggest that it gives a better chance of success. The question of breaking down the different aspects of our approaches and analysing their impact is done in the next section.

8.3 Question 2 – which part worked?

Which part of the combinational PEAR approach worked and can this approach be refined for use as a better or more successful way to integrate new technology into education?

The second research question involves the PEAR process itself. It may turn out that only parts of the Process approach worked in combination with EAR. Knowing this may lead us to a blueprint of a better or more successful way to integrate new technology into education.

To answer this, we evaluated each of the contributing factors for successful ICT4D projects as well as the corresponding link to EAR (originally presented in Chapter 4) as identified by the Process approach to assess the influence each had on the results and the integration process itself - positively or negatively. We also examine the role that the researcher played with a focus on those which are outside of the role normally played by the IT teacher at the school. This was done to identify any external factors to the school that may be necessary in future application of our PEAR approach.

8.3.1 Beneficiary Participation

8.3.1.1 Background

Process Approach Description: Local people's knowledge is important for the successful introduction of the new system. With an intimate knowledge of the context, engaging local people is crucial for appropriate project planning and problem analysis, resource mobilisation, project monitoring and evaluation. Engagement in this change process can also encourage empowerment and knowledge transfer.

Link to EAR: In EAR, participatory techniques are used to involve the user of the systems in all four phases (planning, doing, observing, reflecting).

8.3.1.2 Our Experience

The approach we took was to make use of existing resources and personnel in every aspect of the integration process. In terms of personnel, we made use of locally available personnel e.g. teachers acting as interface designer, students acting as system support, testers and programmers. (See more detail in section 8.3.4 Institutional support). By doing this, we built a sense of ownership of and involvement in the project with almost every teacher and a sizable portion of the students. Furthermore, feedback from the users was used to implement visible changes to the specification. This also added to the sense of ownership.

Additionally; where information was required, for example which aspect of the medium would be of interest, efforts were made to acquire the information from the community through surveys and the collection of opinions.

Where it was not possible to involve other personnel from within, the researcher provided some expertise in order to move the project on. However, the researcher is part of the community, it has been argued throughout wherever this is the case that the skill the researcher is providing is within the expected knowledge of an Information Technology teacher.

Although not directly mentioned as part of the Process approach, our usage of local existing material resources addressed the equipment (or budget to acquire them)

issue that has been consistently challenging in both ICT4D projects and past integration efforts. However, this can be attributed to the ingenuity of the local community in identifying existing resources and taking steps to make use of them. Without the involvement of the community, this may not have been identified.

Participation of students also provided a peripheral benefit of friends of the students getting exposed to the system. For example, friends were shown the different MXiT bots and were told about how homework will be sent to their phone. This helped to spread positive views about the system.

The competition designed to increase participation of the users – both directly in terms of students viewing the information and indirectly in terms of teachers adding more data, was successful. Students helped each other to sign up for the different services and teachers were being encouraged (and pressured in some cases) to enter more data. These activities foster the relationship between teachers and students as IT supporter as well as confidence in using the system by the teachers.

8.3.2 Flexible, phased implementation

8.3.2.1 Background

Process Approach Description: Development should start small and adapt solutions based on feedback and experimentation.

Link to EAR: Involvement of the targetted users who help in deciding when and how to move on to the next phase.

8.3.2.2 Our Experience

We started with a broad intention of integrating the mobile medium and the community honed in on a common aspects over multiple iterations. The periodical nature of the school schedule (based on four 9-10-weeks terms) helped to ensure that each phase was not overly long.

Focusing on one iteration at a time also helped to make sure that only resources that are necessary and proven useful are acquired – thus minimising the financial

requirement of the integration process. A specific example of this was when it was decided to test out the delivery of notes over MXiT despite the indication from teachers' indifference to the usage (57.8% of teachers were indifferent about the service - Survey question 20T1.3, while 86.8% of the students thought that it would be useful or very useful- survey question 20S3). In the same iteration, IT students also got a chance to implement the multiple-choice bot that was not even indicated by the Preliminary Study. Although both of these cases have, not to date, been pursued further than a few teachers agreeing to try out using the service in the next iteration, it does indicate that the phased-in approach being used is allowing different elements to be tried out with the option of stopping the process if part of the community is not supportive. This meant that more resources are not spent on designing and pushing thorough features that will not likely work. This is in comparison to past integration effort which has resulted in features that were not used after a large amount of effort has been spent on putting it in place.

An aspect that the phase-in approach worked well was the teachers' interface introduction via paper-based forms first.

8.3.3 Learning from experience

8.3.3.1 Background

Process Approach Description: Projects should experiment and take risks on potential solutions, but focus on organisational learning as an outcome of failures and taking risks.

Link to EAR: EAR's observation and reflection phases record failure, success, opportunities and challenges and then uses them to plan for the next iteration.

8.3.3.2 Our Experience

Lessons learnt from previous iterations were incorporated into the next and participants could see this happening. This included the appearance of the homework input facility from the paper-based forms to the eventual web-based interface. Teachers could see how their inputs were being used. One teacher attributed this influence to the feeling of higher involvement with the project.

There was also a risk-taking element – participants were able to suggest a direction even if it may have been contrary to the evidence at hand. In some cases, this worked out for the improvement of the overall system. For example, the decision was made to pursue the usage of mobile web even though, the usage number in the survey indicated that only 26.1% had access to mobile web (mostly via WAP as only 10.5% had 3G and 6.2% had Wi-Fi capabilities). Three years after that survey, 51.8% of the students were recorded to be accessing our system via mobile web (STD1/Q6). The increasing trend was picked up by the students and suggested that access via mobile web should be included despite the initial data.

The notes delivery and multiple-choice questions over MXiT were examples of cases of experimentation that did not lead to wider incorporation into the system. However, the experiment did result in showing the teachers the potential usefulness and several teachers indicated their interest in taking this further in the next iteration.

8.3.4 Institutional support

8.3.4.1 Background

Process Approach Description: Utilise local institutions to establish local participation and to improve the capacities of local organisations.

Link to EAR: Unspecified

8.3.4.2 Our Experience

Throughout the integration effort, we tried to use locally available personnel resources as much as possible and the leadership of the project is of no difference. The existing Planning Team took on the role of planning. This group contained all the key decision makers (in terms of the day to day running of the school) and thus was a most suitable structure to plan. The Team also contained key staff who were well respected by both teachers and students. There is more discussion on the leadership provide by this group in 8.3.5 Programme Management)

Teachers and students also participated in a number of activities as outlined in 8.3.1 Beneficiary Participation. The participation of teachers and students not only led to a useful product but it also fostered ownership and a feeling of involvement amongst the users.

Some teachers on the Planning Team felt that this aspect was the main difference between our PEAR approach and past integration approaches. There was a real effort in identifying local personnel for various aspects. The question that was asked whenever there was something to be done was which class or which teacher could help with that particular aspect. Participation of local institutions not only saved cost, but also made people more involved in the project – increasing the chance of obtaining a better product and a better chance of a successful integration.

Students' participation was also encouraged through the mentor structures. The students were regularly asked via their mentors for feedback as well as to volunteer for the project. Several items of feedback brought up by students had their roots in the mentor structures as the place where the idea was first initiated.

8.3.5 Programme Management

8.3.5.1 Background

Process Approach Description: Maintain a flexible, creative, professional, motivated and well-qualified leadership. This will ensure retention of qualified staff and support learning and an adaptive environment where employees are able to contribute their full expertise.

Link to EAR: Unspecified

8.3.5.2 Our Experience

There was high level of support from the top in the integration effort. This support was not financial but their willingness for the existing structures such as management, teachers- and student-based structures to be used in the process. The principal and deputy principal sat on the Planning Team and were able to provide input and decisions as the questions were raised. There was also a grade head

presence on the Team. This afforded us the ability to reach out to both staff and students in good time.

There was a good hierarchical leadership structure amongst the teachers at the school (Staff: Principal – deputy – grade heads – departmental heads – subject teachers). The excellent communication channel from the Planning Team down to individual teachers was excellent. However, it was also the ability for any teacher to attend the meeting and design sessions or just send in input to the Team that was identified as a contributing factor in some of the teachers' comment.

Although the mentor-based structure had a role as being a place where students brought up issues, the classroom-based teaching ideals at the school also contributed. Teachers provided leadership, where necessary, to their students and classes involved in the integration effort. More importantly, teachers allowed the students to participate and lead each other towards whatever they were trying to achieve. The teachers had the ability to pull through the students' leadership and other skills that proved to be essential in some parts of the project. However, the students' ideas were often needed to be kept in check in order to maintain focus on the task's objectives.

The respect and trust placed in the leadership were also essential. During the initial phases of the form design, some teachers could not see the purpose of the forms but persisted with the effort because of the respect and trust in the leadership.

8.3.6 Tasks Done by Researcher Outside of the IT Teacher Role

In this section, we summarise the tasks that the researcher performed that could be regarded as atypical of an IT teacher. We also critically examine the skill required to complete these task and motivate why some of them could be considered to be reasonable for IT teachers to possess. For the other cases, we look at what it would take for the roles to be fulfilled by local members of the community or an external entity if this is absolutely unavoidable.

8.3.6.1 Technical Tasks

These tasks include those done during both T- and S- iterations and were as follows:

- **Code to process input from HTML Forms:** Teacher designed forms were converted to HTML to allow for information to be processed by the backend. While students attending the extramural IT Club were able to make use of PHP in conjunction with the SQL statements developed by the IT class, students were not able to, by themselves, put everything together. This meant that the researcher had to support students in writing code in PHP and verifying that they work as expected.
- **Implement designed database with optimization modification for EIS:** Initial design of the database used to store homework and test information was derived from the spread sheet used to store the data in the first two T-iterations. IT students were able to apply the normalisation process in Microsoft Access – a task that is within the IT syllabus. However, the implementation of the tables in MySQL (the database in use by Moodle whose server the EIS system was piggy-backing) was done by the researcher. The necessary optimisation was also done by the researcher.
- **Implement additional code for EIS:** Students implemented PHP code that was basic in structure and lacked code to prevent common forms of attack such as SQL injections. The researcher had to implement code to ensure that the system is safe against such attempts. Similar effort was made in terms of backing up of data and tracking currently logged in users.
- **Create MXiT library for use by the students to explore the use of MXiT:** During the S-iteration, students were given a Java library that allowed them to implement MXiT bots in a similar way to asking the user for input and outputting data to the user. This library was developed by the researcher.
- **Implementation of the content delivery system:** The system that is used to deliver content to the supported platforms such as MXiT and the web were designed and implemented by the researcher.

In South Africa, secondary school teachers are required to have studied relevant undergraduate courses in the subject that they would teach in – Computer Science being the pre-requisite for Information Technology (South African Department of Higher Education and Training, 2008). IT teachers, with such qualification, are capable of these tasks. Even if they are not well-versed in the required programming language, they should be able to learn the language within a reasonable time-frame.

8.3.6.2 Process Approach and EAR related Tasks

The researcher provided the initial introduction of the Process approach that was taken throughout the integration process. Motivation was provided for various aspects of the process such as local participation and multiple phases.

In terms of EAR, the researcher mainly observed and was present in his role as Information Technology teacher in most of the meetings. Meetings in which he was not present were reported back on or summarised for another meeting in which the researcher was present. Active participation within tasks such as design and programming were undertaken within the typical role of the Information Technology teacher. Where this was not possible, it has been motivated that these tasks were within the expected skill set of an Information Technology teacher.

It was, however, clear from the comments that teachers felt that the presence of the researcher acting as one of the participants – even if he only contributed when asked – was the unifying presence throughout the project. Some teachers attributed part of the success of the project to the researcher ‘driving’ the project even though the actions of the researcher did not involve active contributions wherever possible but only when necessary. In fulfilling the role of a typical IT teacher, even with effort to minimise participation, the researcher may have ended up having a higher than expected impact. This was discussed with teachers and students in the last feedback meetings resulting in the following possible explanations:

- Teachers see the researcher as having the most expertise in the area. They would end up asking for advice and approval even when not needed. This unintentionally increased the level of influence the researcher had on the project. This also avoided the top-down or researcher-driven perception by participants, but still allowed positive contribution from the researcher.
- Students naturally looked to their teachers to provide input even in environments where they were given room to explore. This also increased the level of influence the researcher had on the project especially in those tasks involving students.

- The researcher was present across the majority of the meetings and activities mostly for EAR-based observation purposes. As other participants were only present in activities they were involved in, the researcher was eventually seen as the person who knew the project very well.

8.3.7 Discussion on to the Second Research Question

8.3.7.1 *Our Combinational PEAR Approach*

Although the Process approach involves management support and successful ICT4D projects have had high community participation level, they were often driven by outsiders such as a mobile service provider (Knight-John, 2008) or a bank (Huges & Lonie, 2007). On the other hand, past integration experience at schools and our own Preliminary Study indicated that the top-down or an outside-in approach should be avoided, but the challenge for schools was how one could start a new integration effort without resorting to either approaches or the perception of those approaches.

Our PEAR approach provided a solution by adding to the successful ICT4D Process approach model, the presence of an expert whose objective was not to actively drive the process, but rather to passively observe and enable participants to bring their own solutions to the Process approach.

Eventually, the participants do come to accept the researcher as the driver of the process but the EAR aspect of our combinational approach allowed for slow acceptance of this by the community without the effort being seen as top-down or outside-in at least not initially when the resentment could have been high.

From our results, the aspects of the Process approach worked well at the participating school as discussed in the previous sections. However, in order for our combinational PEAR approach to work at a school, the role of the researcher would have to be played by a member of the school community.

The role of this individual should be in line with the EAR model followed by the researcher in that he/she should be an observer in all meetings and to provide technical expertise where necessary but only when asked for. They should also

ensure that they have kept track of all the happenings within the project in order to answers any questions regarding other aspects of the project. The individual should also have bought into the integration effort but does not necessary have to have all the skills necessary. Together with the Planning Team, the individual can seek out existing local institution to help with any challenges that arise.

8.3.7.2 Recommendations for Schools

We now take a look back at the PEAR approach we used to integrate the mobile medium and discuss our observation of the effect of the various aspects of the combinational approach. We then provide a list of recommendations based on each observation on what should be done by a school when applying the combinational approach.

1. The phased-in aspect of the Process approach combined well with EAR phases of planning, doing, observing and reflecting. We started from a central idea that was explored over multiple phases by small groups of users. We started small, design and implement part of a system, then ran it while observing and collecting data about what is going on. We then held reflection sessions with designers and users. The group then took account of what was discovered and the cycle started over. The approach worked by focusing on the aspect of the mobile medium that is likely to be useful to as many of the user base as possible.

Recommendation: Start small and build up in phases based on what was discovered in each phase. That way, not everything has to be thrown away if it did not work and this is also a chance to prove that the system will work.

2. The Process approach encouraged involvement of many groups of people (local institutions). We tried as much as possible to identify suitable groups from within the school. In some cases, we had to be quite creative, but the variety of skills amongst staff and students surprised even the most skeptical amongst the Planning Team. We also tried to build up from local leadership areas as a way to induce more people to be involved with the project. Such

localisation also contributed to lowering the cost of the integration itself. With cost being an issue in past integration project, this aspect was quite enticing. However, this came at the potential risk of failure, but – combined with phased-in approach – the risk is limited to only that one part being implemented. With the Process approach – failure is an option and does contribute to the betterment of the next iteration. Failure experience in one phase would in any case, cost less than the failure of the entire integration effort as experienced in the past. In cases, where skills were not readily available, students could be taught to do the job. We also had contingency plan of reaching out to the parents but this was never necessary.

Recommendation: Involve as many people from the school as possible. Find the relevant skill in teachers or teach the students the skill. Reach out to the wider school community such as parents. Involvement of users also helps later on to promote the adoption of the medium – so it is good to involve as many as possible.

3. Leadership from the top is necessary but the conglomeration of leaders representing different groups within the community was also important. These leaders must be well respected within the community – within the school, these respected leadership structures, with respect to teachers normally, already existed within the school. Structures involving the students such as the mentor structures or the students' representative structure could also play a part but the ability of teachers to pull through leadership and other skills from their classes involved was also essential.

Recommendation: Existing leadership structures at a school will definitely help to provide the lead but create strong leadership within the group – allowing everyone the space to speak out.

4. Our experiences showed that there were large amount of similarities between the developing community and a school. The similarity is large

enough for the Process approach to make a positive effect on the integration effort. A closer look shows us that the recommended structures that should be strived for in a developing community were readily present in a school. Examples include well-respected leadership structure, large population of local personnel with varying skills and perhaps most importantly, the desire to make a difference to the school and their own education. This applies in every phase not just design and testing.

Recommendation: Make the project a school project – get everyone involved. In our case, we created a competition to promote the use of the system. This had a cascading effect in getting many more people involved.

5. Lack of leadership with a clear understanding of the objective may result in a diversion away from the initial purpose. This could have happened a number of times in the design meeting where the possibility of a diversion could have occurred. The focus on what the objective was helped to redirect the effort. However, this does not mean that the potential to explore a different direction was eliminated – there is room for experimentation as long as the focus is kept on the objective.

Recommendation: Make sure the school management and those in the leadership roles understand and accept the purpose of the integration as well as the approach that are being taken.

6. Deadlines and iterative approaches do not work well together. The goal of a phase should not be based on a deadline but rather on the outcome. The phase is finished when the task is accomplished (or failed). Although we did set a timeframe for each phase, one of the flexibilities we put in place was the ability to stop that phase at the acknowledgement of failure or to extend it if necessary. However, a school is always limited by the end of term and end of year so that is naturally unavoidable.

Recommendation: Do not create deadlines for when tasks should be completed. Set up the timeframe so that there is enough time for the task to be accomplished but also have the flexibility to end earlier or finish later.

7. Additionally, the leadership needs to consider the level of explanation to the user of what is being done and the purpose against the risk of confusing the user base. At times, because the leadership itself is not sure of the direction (for example, where you proceed to depends on the result of the current iteration), all those involved must be able to trust that what is being done is consistent with the initial purpose. Strong and well-respected leadership is essential. In some cases, it may be advantageous to abstract away the complexity. In our case, the user interface design is reduced to the paper-based form design process. The teachers involved did not know what would become of the forms.

Recommendation: Tell teachers and students about the overall aim of the project, but there is no need to get down to the small and technical detail. Trust that the fact that everyone is empowered to make corrections that together they will respond to point the effort on the correct course.

8. The importance of the IT teacher was essential in our integration effort. Not every school offers the subject of Information Technology but could a Computer Applications Technology or computer literacy teacher play the same role? The IT teacher played the role of technical advisor to the group – the literacy teacher could possibly have played this role. The roles of the IT class and IT Club are similarly in question. The roles that may be difficult to substitute for IT teacher and the IT classes, such as programming and the more complex database design could potentially be played by an external person. This may still have the benefit of reducing cost (when compared to a wholly external solution), but at the loss of local participation that was essential in our effort. We did have a plan to approach the parent body should we require a skill that did not exist at the school. However, this was

not necessary in our case, but this could be a better solution than outsourcing to an external entity.

Recommendation: It may be the case that IT-related skills do not exist within the school walls and are required. Teach the students the skill if possible or approach the parents for help. Only consult an external entity, if none of these are possible.

9. Students' participation in the project is important if only to help spread positive views about the system. The students were often seen as having lesser competency than they actually had. They should be afforded opportunity to contribute even if the end result does not work out – their presence can still contribute to spreading the good word on the project. It is important also that students are kept on track with the objectives of the task they are working on.

Recommendation: Get as many students involved as possible. They may have good ideas and/or they may just help spread the word.

10. The importance of the IT Planning Team must not be underestimated in the planning. While it is possible that any groupings of teachers would be able to do the same job, the Planning Team's experience in dealing with IT-related matters was valuable in the different aspects of the process (design, reflection etc.). This experience was built up over a long period of working with IT related issues.

Recommendation: Form an IT Planning Team if there is not one. Their experience will be helpful in any integration process.

11. The role played by the researcher in observing, recording and linking various activities is essential. However, this should not be a top-down or leadership role initially. This role player should be member of the school community and should be someone who is an expert in the medium being integrated. With respect to IT-related medium – we have motivated that a

typical IT teacher present would have the necessary technical skill to play this role. The role player would also need to have an active interest in seeing the project through. The role of this person is not to drive the project, but to facilitate participants in deriving their own solution and to provide technical expertise where necessary.

Recommendation: Identify a person who is willing to play this role.

In the next chapter we provide the conclusions to the project.

University of Cape Town

9

Conclusions

In this chapter, we summarise the research findings, our contribution to the field as well as future research opportunities.

9.1 Research Questions

9.1.1 Problem Outline

Successful integration of a new teaching medium into a South African school is very challenging. By looking at the past integration efforts of new technologies, as well as through our own initial study and on the field, we recognised similar results and challenges in the efforts to introduce information and communication technologies (ICTs) into developing communities.

We developed a novel PEAR approach to medium integration in education by combining the Process approach used in the introduction of successful ICT projects into developing communities with Ethnographical Action Research (EAR) techniques as well as taking into account recommendations made by past medium integration in education.

We proposed that such a combination approach could bring about a successful integration of a new medium into a school. We developed and applied this combinational PEAR approach in order to answer these research questions:

1. Does this combinational PEAR approach result in a '*better*' or more '*successful*' integration of a medium into education?

2. Which part of the combinational PEAR approach worked and can this approach be refined for use as a better or more successful way to integrate new technology into education?

We motivated that the mobile medium was a suitable medium to test our combinational approach. In order to apply the PEAR approach, the researcher joined a high school in Cape Town as an Information Technology teacher. The school became an EAR site in which the PEAR approach was used to integrate the mobile medium into the school. The study, as presented in this thesis, took place over three years, but the project itself is still on-going and has undergone further iterations since.

9.1.2 Findings

9.1.2.1 Question 1

Does this combinational PEAR approach result in a '*better*' or more '*successful*' integration of a medium into education?

This question is in relation to the integration process. We measured this in two ways. We asked the users to evaluate the usefulness of the result and the integration process itself in comparison with past experience.

96% of the teachers and 78% of the students, who used the system, rated the system 4 (of some use) or 5 (useful). Although this is very subjective and not easily comparable with past integration experiences, the result does nevertheless show that the service was considered useful by most of its user. This is important, as a successful integration process could not be considered a success if the service it is trying to introduce over that medium is not useful.

The teachers were also asked how the introduction of the EIS reminder service went in comparison to their past ICT introduction. 96% of them rated the introduction system as better (52%) or much better (44%). Although, the question of whether or not an ICT introduction process is considered better or a success is very subjective and is relative to past experiences, this is still an indication that the majority of the teachers were positive about how the service was introduced.

We also evaluated the integration process with respect to the challenges experienced in ICT4D projects and/or past integration experiences. This can be summarised as follows:

Cost of Infrastructure and Personnel: Use of existing resources and personnel in the integration effort saved cost. Once the system was proven useful, more resources would be easier to source. Much of the expertise already existed at school in teachers and students. Teachers and students were involved in various aspects of the system such as the design of the interface and database development. We also found that the programming skills of the researcher were still required to either teach the students or to implement part of the system (database normalisation and PHP programming). However, the level of skill required does not exceed the qualification requirement of an Information Technology teacher and that this skill set should be present in a school offering the subject.

Users' ICT Literacy level: Even though the teachers at the school did not possess basic computer literacy training, the design process incorporates what teachers are already able to do well. By doing this, the levels of training and subsequent support required were also reduced. Further support, which many teachers felt was not necessary, included student-based support. A trial run of the system without the data being published also boosted the teachers' confidence and competency level before the actual launch of the system.

Purpose of the project to the user: Our project consisted of not only extensive consultation but also participation of users – teachers and students. 88% of the teachers felt more involved with the development of the system than expected, while 41.3% of the students felt the same way. This could be because almost all of the teachers (except for those who joined after the different iterations) were involved in the project while only 23% of the students were. Students were also only able to take part in a much shorter span of time.

Timing of users' involvement: There is reduced amount of training to be done since teachers are already familiar with the system that they have helped to design. Additionally, they were also able to make one-to-one appointments for training at a time suitable for them. The phased-in approach also helped teachers to get used to small chunks of the system at a time.

User friendliness of the system: Most of the teachers and the majority of the students found the system easy to use. This was attributed to the phase-in introduction of system. The fact that the users participated in the design meant that the teachers were already familiar with the system and that it was designed for the specific context it was deployed in.

The majority of the users found the resultant system useful while almost all teachers found the integration process to be better than their past experiences. Comparison with past integration challenges also showed us that our combination approach produced a system that addressed all of the challenges to those integration efforts. This integration process can then be said to be more successful than those experienced by teachers in the past as well as in comparison to those outlined in the Chapter 3.

9.1.2.2 Question 2

Which part of the combinational PEAR approach worked and can this approach be refined for use as a better or more successful way to integrate new technology into education?

The second research question involves the combination process itself. To answer this question, we evaluated each of the contributing factors for successful ICT4D projects as well as the corresponding link to EAR (originally presented in Chapter 4) as identified by the Process approach to assess the influence each had on the results and the integration process itself - positively or negatively. Here is a brief summary of the evaluation of each factor.

Beneficiary Participation: We made use of existing resources and personnel in every aspect of integration process. By doing this, we built a sense of ownership and involvement in the project with almost every teacher and a sizeable portion of the students. Furthermore, feedback from the users was used to implement visible changes to the specification. This also added to the sense of ownership. Where it was not possible to involve other personnel from within, the researcher provided some expertise in order to move the project on. However, the researcher is part of the community, it has been argued throughout wherever this is the case that the skill the researcher is providing is within the expected knowledge of an Information

Technology teacher. Use of existing material resources also helped to minimise cost. This was reflected in the ingenuity of the local community as they identified existing resources and took steps to make use of them. Without the involvement of the community, these resources may not have been identified.

Flexible, phased implementation: We started with a broad intention of integrating the mobile medium and the community honed in on a common aspects over multiple iterations. The periodical nature of the school schedule (based on four 9-10-weeks terms) helped to ensure that each phase was not overly long. Focusing on one iteration at a time also helped to make sure that only resources that are necessary and proven useful are acquired – thus minimising the financial requirement of the integration process and ensuring that more resources are not spent on designing and pushing thorough features that will not likely work or be useful. This is in comparison to past integration effort which has resulted in features that were not used after a large amount of effort had been spent on putting them in place.

Learning from experience: Lessons learnt from previous iterations were incorporated into the next and participants could see this happening. There was also a risk-taking element – participants were able to suggest a direction, even if it may have been contrary to the evidence at hand. In some cases, this worked out for the improvement of the overall system.

Institutional support: The existing Planning Team took on the role of planning. This group contained all the key decision makers (in terms of the day to day running of the school) and thus was the most suitable structure to plan. The committee also contained key staff who were well respected by both teachers and students. Students' participation was also encouraged through the mentor structures at the participating school.

Programme Management: There was high level of support from the top in the integration effort. This support was not financial but their willingness for the existing leadership and other existing structures to be used in the process. The principal and deputy principal sat on the Planning Team and were able to provide input. There was also a grade head presence on the committee. This afforded us the ability to reach out to both staff and students. There was a good hierarchical

leadership structure with excellent communication channel down to individual teachers. The respect and trust placed in the leadership were also essential.

We also took a look back at the PEAR approach we used to integrate the mobile medium and make these recommendations on what should be done when applying the PEAR approach.

1. Start small and build up in phases based on what was discovered in each phase. That way, not everything has to be thrown away if it did not work and this is a chance to prove that the system will work.
2. Involve as many people from the school as possible. Find the relevant skill in teachers or students or teach the students the skill. Reach out to the wider school community such as parents. Involvement of users also helps later on to promote the adoption of the medium – so it is good to involve as many as possible.
3. Existing leadership structures at school will definitely help to provide the lead but create strong leadership within the group – allowing everyone the space to speak out.
4. Make the project a school project – get everyone involved.
5. Make sure the school management and those in leadership roles understand the purpose of the integration as well as the approach that is being taken.
6. Do not create deadlines for when task should be completed. Set up the timeframe so that there is enough time for the task to be accomplished but also have the flexibility to end earlier or finish later.
7. Tell teachers and students about the overall aim of the project, but there is no need to get down to the small and technical detail.
8. It may be the case that an IT-related skill does not exist within the school walls and needs to be acquired. Teach the students the skill if possible or

approach the parents for help. Only consult an external entity, if none of these are possible.

9. Get as many students involved as possible. They may have good ideas and/or they may just help spread the word.
10. Form an IT Planning Team if there is not one. Their experience will be helpful in any integration process.
11. Identify a role player from within the school who has an active interest in seeing the project through. The role of this person is not to drive the project but to facilitate participants in deriving their own solution and to provide technical expertise where necessary.

9.2 Research Contributions

9.2.1 Novel Application of the ICT4D Process Approach and EAR

We have applied a novel approach in integrating new medium into an educational environment. We combined an effective approach to integrating technology into a developing community and ethnographic action research in which a researcher acts and interacts with participants and stakeholders as one of their own. In doing so, we have expanded the application of the ICT4D Process approach outlined by Heeks et al. (Heeks & Molla, 2009) to communities outside of what is typically regarded as a developing community by ICT4D researchers. Although the participating school was located in what many regarded as a developing country, namely South Africa, the school itself can hardly be profiled as resource-scarce as it is able to provide for the educational needs of its students. However, there are enough similarities between the school community and developing communities for the ICT4D Process approach to make a difference.

The ICT4D Process approach gives the researcher doing EAR a way to extract contributions from the participants as we have observed. It is arguable that EAR by itself could also extract a similar system but the push for inclusive design and drive

for community-wide (institutional) success from the ICT4D approach made a difference in creating an end-product that is useful for everyone involved.

9.2.2 An Alternative Approach to Integration in Education

In applying the PEAR approach, we discovered that the role the researcher had to play was minimal and that the participating school already possessed most of the necessary resources – both in terms of material and human resources. Furthermore, in our specific case, a capable Information Technology teacher should be in possession of these skills in the first place. Even if we had encountered an area where there was no existing skill within the school, there were other sources of such skills that may not cost the school at all. Parents readily support students in the past at the participating school – from lighting needs at a cultural evening to donation of fruit juices for field trips. The school's local resources and personnel extend beyond the school gates.

Our PEAR approach not only got rated highly by the teachers in comparison to their past experience, but has overcome the challenges experienced by past integration effort including our own in the Preliminary Study. Just because the combination PEAR approach was a success for our particular case, there is no guarantee that it will produce a successful integration in other cases. Successful integration depends on more than just the integration process itself. It also depends on the educational value of the new technology itself. These factors need to be carefully dealt with in order for the integration to stand a better chance of success.

However, with an educationally sound technology or medium and a school wanting to be involved, our combinational PEAR approach is a more cost-effective approach to integration than the traditional top-down approach. It is an alternative approach that should be considered by a school that wants to push in technology that will make a difference but does not come at a financial cost. The approach also stands a better chance of being accepted by the school community as it is not as a top-down approach but as a more inclusive approach to integration.

9.3 Future Works

9.3.1 Further Application of PEAR Approach

The combination PEAR approach should be used to integrate new medium and technology into more schools. For a comparative study, it could be used in an attempt to reintegrate medium that has previously failed to be integrated for reasons such as lack of funding. The PEAR approach encourages the use of local institutions and such cases could allow the approach to be evaluated more comparatively against the previous approach. Further application without a researcher present will also allow that role to be evaluated.

9.3.2 Sustainability Question

Sustainability of ICT integrations was raised by Khanya and other past attempts. It is not clear what work needs to be done to sustain the integration. Would the Planning Team's regular meeting be sufficient to push the effort forward? What about the quality of the work done by the students? Would the work have to be eventually re-implemented by professional programmers either because they fail or no new features could be added on because the knowledge has been lost because the student groups who implemented it have left? What safeguard can be put in place in order to ensure that knowledge put in by one generation of students and teachers are not lost through to the next generation?

University of Cape Town

Appendix A: Preliminary Study

A.1 Objectives of the Study

By introducing mobile devices to students and teachers to be used in and out of the classrooms, we were hoping to use them as technology probes. Our objectives were:

- [Ao0.0] Discover issues and challenges when integrating technologies at schools;
- [Ao1.0] Discover issues and challenges when conducting research at schools;
- [Ao2.0] Discover issues and challenges when conducting research with mobile devices at schools;
- [Ao3.0] Collect ideas on how the mobile medium and devices could be used in and out of the classrooms - including usage, device & other related information;

and to use any discovered information as basis to conduct further studies.

A.2 Design of the study

A.2.1 Profile of the School

The school that took part in this study is a state co-educational secondary school with students from Grade 8 to Grade 12 (13-18 years old). The school is located in suburban Cape Town and has about 850 students and 38 teachers. The reason the school was chosen was because one of the teachers volunteered for the project and this helped us to avoid delay in having to apply for permission to conduct external research from the Department of Education.

A.2.2 Issues Experienced

At the outset of the studies, a meeting with the school's headmaster and Head of Academic issues was held. The following limitation on the studies were motivated and requested by the school.

- **Time Limitation:** Due to the upcoming end-of-year examination, the study can only be conducted over three weeks with one-week preparation time. The alternative is to wait for four months until the start of the new academic year.
- **No mobile phones in the classrooms:** The school bans the use of any unapproved electronic devices including mobile phones in the classrooms. However, certain devices such as calculators and electronic translators used by foreign students were allowed.
- **No network / Internet connectivity:** The school was not in a position to provide Internet connectivity for the device. The school would also not in a possible to grant permission for us to augment their existing wireless network with additional access points due to security concerns. Furthermore, concern of disruption in class was also raised. It was felt that the majority of the teachers might not have the technical knowledge to prevent or deal with such cases. Network and Internet connectivity were regarded as important and was incorporated into the second PDA study at a late stage.
- **No observation possible in class:** At the time, no external person is allowed to be present in the classroom. This was a Department of Education/Labour union agreement, which only allow approved personnel from the evaluation arm of the Department or school personnel to be presented in class.
- **Permissions from Parents/Guardian and the Department of Education¹⁶ (DoE):** The school required that permission be sought from parents/guardian of the students taking part so that they are informed as to the purpose and the detail of the study. Furthermore, a special permission from the DoE will need to be applied for, as this is an external research project.

A.2.3 Dealing with Issues Raised

Issues	Implication	Comment / Solution
Time Limitation	Study will need to be completed in three weeks. Inclusion of software for usage monitoring was not possible	Use of indirect data capturing method including usage diary and interviews

¹⁶ The Department was split up in 2010. The DoE's secondary education division has been renamed the Department of Basic Education (DoBE).

Issues	Implication	Comment / Solution
No network/Internet Connectivity	No network-based usage capturing method was possible.	Use of indirect data capturing method including usage diary and interviews.
	No usage that involves the network or Internet was possible	This was included in the second PDA study.
No mobile phone in the classrooms	No mobile phone can be used in the study.	Personal Digital Assistants (PDAs) were used instead.
No observation in class	No direct observation of the students and teachers could be done	Use of indirect data capturing method including usage diary and interviews.
Permissions issues	Study will need to be delayed until permission is granted from the DoE.	The study was modified to a collaborative study between the school and the University of Cape Town. With involvement of a teacher in the process the study became an Internet project and did not require the permission from the DoE.

A.2.3.1 Use of PDAs as Mobile Devices

At the start of the study in 2005, smart phones were still maturing and even with increasing technological advances of mobile phones, they still lack the processing power and user interfaces to accommodate useful educational software [ref]. Personal Digital Assistants (PDAs) make a viable test-bed for assessing future educational technologies as their interfaces and functionality foreshadow the future of mobile phones. More importantly, the participating school approved the use of offline PDAs in this study.

A.2.3.2 Availability of testing equipment

The PDAs we used were sponsored and as such only a limited number were available for distribution to research participants. This also meant that only a portion of learners and educators can participate in a study. Once again this may have an impact on the extent of the data collected; as learners have a limited number of other participating learners to interact with. The potential for the disruption in class is also higher since some learners do not have access to the devices and may distract those who are participating in the study.

A.3.3.2 Direct and Indirect Data Capturing

Other studies such as Davis (Davis, 2002) implemented monitoring usage of mobile devices using permanent or semi-permanent communication (usually wireless) infrastructure in schools. These studies track usage of the devices in real-time and constantly upload data to a central server for storage and analysis. The absence of an extensive wireless infrastructure in the participating school (and indeed most schools in South Africa) makes this approach practically impossible. This situation coupled with the insistence that neither direct nor video-based observation can be done by external researcher, limited the number of quantitative approaches which can be adopted when monitoring the usage of mobile devices in the participating school.

The ability to record live data can be important in the study of the introduction of new technology. However, delayed indirect measuring methods can also be useful, as well as being cheaper to conduct. Instead of measuring live data, participants can be asked to fill in a set of questions periodically. This data can be then cross-referenced and verified with interviews and questionnaires conducted at the strategic points in the study. However, the accuracy of such methods needs to be determined.

A.2.4 Other Issues of concern

Carrying out scientific studies in South Africa has a number of other challenges which we were keeping a look out for to evaluate their impact on the use of the mobile medium. These are outlined below.

A.2.4.1 Security of devices

Physical security is a concern for researchers when conducting studies with mobile devices (Babbie & Mouton, 2001) (Tacchi, Slater, & Hearn, 2003) as their availability is limited and are costly to replace. Crime levels are relatively high in South Africa (United Nations Office on Drugs and Crime, Centre for International Crime Prevention) (South African Police Service, 2006) and the potential loss of these devices is a legitimate concern. A number of solutions can be implemented but they may cause a detrimental effect on the quality of the results obtained. A possible solution is to only allow learners to use the mobile devices under strict observation. However, this will obviously impact the final result. Furthermore, the limited number of researchers might make this impractical. Another possible solution is to require learners to return their devices at the end of the school day. This, however, removes all data on after-school and home usage completely.

A.2.4.2 Educator work process

Educators' workload in South Africa is already high with larger than average class size (NationMaster, 2005) and new demands of curriculum changes and increasing assessment requirements (South African Government White Paper, 1998). This limits the amount of time educators are able to commit to academic studies into uses of technology. Furthermore, the increasing stress and expectations of educators may limit their adoption and usage of existing technologies in their work processes, not to mention adopting or assessing new technologies.

A.3 Our Study

Due to the number of devices available, a limited number of learners and teachers took part. Participants only kept the devices for three weeks due to the then-impending examinations.

A.3.1 The Equipment

Each participant was given an HP IPAQ 4190 (which is equipped with Bluetooth and Wi-Fi technologies) and accessories together with a CD of educational freeware and shareware. These were a mathematical graph plotting program, scientific calculator, periodic table program that gives information on the different element, an English dictionary, English-Afrikaans dictionary, note-taking program with simple shape drawing and a voice recording program. The devices were distributed with no additional reading material other than standard manuals provided by the manufacturer. An electronic how-to tutorial provided by the manufacturer on how to use the basic features of the devices was also given to the participants.

A.3.2 Participants

As only 16 devices were available for the study; therefore, ten learners and six educators took part.

A.3.2.1 Students

Ten participants were drawn from the Grade 11¹⁷ computer studies classes. All were 16 to 17 years old. The gender split was nine males and one female; this is consistent with the profile of this class. They were selected from this class because they are more likely to be able learn to use the device within the short time-frame of the study.

A.3.2.2 Teachers

Six educators agreed to take part in the studies. Four taught the learners taking part in the study, while two did not. They all teach Grade 11. There were no computing criteria for educator selection.

A.3.3 Indirect Data Capturing Methods:

The following indirect measuring methods were employed:

¹⁷ Equivalent to the US 11th Grade and UK Form 4. The students in Grade 11 are typically between 16 and 17 years old.

A.3.3.1 Paper-based Questionnaire

This was used to find out a participant's initial knowledge and impression of computing devices, including computers, cellular phones and PDAs. It was also used to evaluate educator's end-of-study thoughts.

A.3.3.2 Usage Diary

A usage diary was given to each participant. He or she was asked to fill in sections of the diary at the end of each class and other sections at the end of each day. The diary queries each participant on the level and purpose of device usage; as well any software installed or removed that day.

A.3.3.3 Interviews

In the middle of the study period, participants were interviewed. During the structured interview, various issues were dealt with, ranging from technical difficulties, input method, usage, interaction with others and the usage diary. Additionally, participants were also free to express any issue concerning the study.

A.3.3.4 Online Questionnaire

When the learners returned the devices they were asked to fill in an online questionnaire. The questionnaire was adaptive and was generated dynamically from the data collected from the first (paper-based) questionnaire and interview.

Each participant was queried on their impression of the device and its usefulness or lack of in class. They were also asked for the perceived usage amount in each class.

A.3.3.5 Disruption Report Forms

A number of disruption report forms were made available to all Grade 11 educators. The educators were asked to fill in any significant disruption in their class that were caused by the introduction of the PDAs.

A.3.3.6 Interview with teachers

After the study has been concluded, six Grade 11 educators were interviewed. Four took part in the study while two did not. They were asked to comment on the following issues in the following order:

- Their past experience with technology integration in the past and how they felt about it
- Their general comment on the mobile technology for use in education
- Specific experience with respect to use of the PDA by the students and their own use of the devices.
- Any usage attempts that they find particularly useful.
- The disruption caused by the PDAs during and out of class and steps, if any, they took to correct the situation.

A.3.3.7 Loss of Equipment Report Forms

A report form was made available to students and educators to report the loss of the PDA. The form asked for the description of how the PDA was lost.

A.4 Findings and Analysis

A.4.0 Relating to Objective Ao0.0

Discover issues and challenges when conducting research at schools

AR0.0.1 – Priority of new technology introduction

Even in well-resourced school, ICT equipment is not a priority. Other priority that came through from teachers and staff were textbooks, whiteboards, stationery supplies etc. There is a general lack of additional and supplementary educational resources even in a Quintile 5 schools (schools that cater for the least poor).

All teachers mentioned that if additional funds were to be made available, it should go towards teachers' salary as they felt that the profession is not a well-paid one in comparison to other professional services.

Reliable electricity provision and affordable Internet connectivity are still issues in South Africa even at a well-resourced school.

A_R0.0.2 – Resources required for integration

The participating school does not have dedicated personnel and often have to hire external expert at high cost in order to implement and support the technology. At the participating school, only one dedicated IT technician are hired to look after all the computers at the school (more than 100 in the latest count). The technician is already fully stretched for maintenance purposes. New projects were introduced by external personnel – the latest project being the Khanya Project (Western Cape Department of Education (WCED), 2011). The Khanya project's was aimed at exploring the use of technology 'as an aid to augment teaching capacity'. Most of the project's integration personnel were sent by the WCED.

There is a need for projects like Khanya because schools do not have financial resources to justify the budget necessary for implementation and upkeep of equipment and/or system. Teachers, students and other users do not possess the necessary skill to make use of the technology effectively in teaching and learning.

A_R0.0.3 – Top down integration

Technology integration projects are often pushed down from the top with little consultation with end-users. Teachers also raised concerns that previous ICT integration efforts (Khanya Project) at the school had been 'forced' on them with no consultation prior and no support after implementation. This came despite the stated objectives of the Khanya project as being maintenance of equipment and user support after the integration phase.

A_R0.0.4 – Integration plan

Teachers, students and other users are busy with educational activities throughout the day and training (and other activities) must be timed accordingly. Technologies to be integrated were often designed for other purpose. Technology does not fit well within the educational context and have to be extensively modified. Other aforementioned factors make this difficult to achieve.

A.4.1 Relating to Objective Ao1.0

Discover issues and challenges when conducting research at schools

AR1.0.1 – Effectiveness of data collection methods

The following tables reflect the different methods used for data capturing and corresponding return rate (split into the number of returns received as scheduled, with a follow-up and none at all) and complete rate.

Students (10)

	On due date	On Follow up	Not received	% Field completed (average)
Paper Form	10	0	0	96
Interview	7	2	1	100
Diary	7	1	2	63
Online Form	8	1	1	100

Teachers (6)

	On due date	On Follow up	Not received	% Field completed (average)
Paper Form	4	0	2	71
Interview	6	0	0	100
Diary	2	2	2	45
Online Form	4	1	1	100

In some of the student's usage diaries, some data was suspicious: for example, some learners repeatedly filled in the same numbers and comments for different times or days. Conflicting information was received from the usage diary when compared to the answers to the final questionnaire. For a particular question concerning use of PDA in class, less than 30% of the learners' answers that were received from different sources actually matched. Some learners also complained about how unsuitable

PDA's are for classes during the questionnaire, but yet praised them in the interview. Generally, more negative opinions were expressed in the diary than in the questionnaire or interview by the same participant.

Online questionnaires gave the best return and completion rates. This might be due the ease of completion and the fact that the questionnaire was adaptive (this reduces it to only asking relevant questions to each participant.) However, this method is impractical at schools where limited or no Internet access is available.

Usage diary should be more reliable if filled in regularly. However, it was clear that this did not happen in most cases and is true for both learners and educators.

It is unclear which of the different methods were more accurate. However, the fact that more negative opinions were expressed in the diary might be more reflective of the true feelings of the participants. Much lower completion rate for teachers could be due the high workload that a teacher experiences on a day to day basis.

Comments

- The methods are less effective with teachers. There is a need to provide incentive – perhaps by making them a stakeholder in the study.
- Online adaptive questionnaires which are better at capturing data should be employed where possible.
- The use of multiple methods is necessary to pick up any data inaccuracy.

A_R1.0.2 – General Response/Reaction to the Research

Teachers expressed mixed responses to the research over all. Half of the teachers who took part responded positively to the idea of using mobile medium in class – even though most did raised concerns (See A.4.2 Relating to Objective A_o2.0). They also generally welcome any technology that would aid in teaching.

The other three teachers reacted negatively towards using the mobile medium and were in fact against using further technologies in the classroom. Two expressed the opinion that technology integration will always fail because not enough support is provided and that the teachers will need to do more work than currently in order to make it work for them. They also questioned whether mobile technology will be 'forced' on them with no consultation prior and no support after implementation.

All students were positive about the use of the PDAs as well as the idea of using the mobile devices 'for good' as one of them put it.

A.4.2 Relating to Objective Ao2.0

Discover issues and challenges when conducting research with mobile devices at schools

AR2.0.1 - Disruption in class

In the first week, students report high borrowing rate of the PDA. Some learners were not able to make use of the PDA for entire periods as their friends constantly asked to see and use the device.

Two incidents of confiscation were reported, mostly due to the use of PDA for non-educational purpose during class. Both incidents did not involve other students.

All learners made use of the PDA for non-educational purposes at one time or another during class. Only two incidents mentioned above were reported in the interview. Educators also mentioned in the interview that there were incidents where they have noticed learners using the PDA for non-educational purpose. They then asked for the PDA to be put away and the learner complied. They did not see these incidents as serious disruption.

Only one disruption report form was received but it was not for either of the two confiscation incidents. This could indicate that educators see the report

forms as troublesome. A pair of students also made use of Bluetooth to send messages during class. This was not noticed by the educators.

The distribution of PDAs to a limited number of participants contributed to some disruption with many non-participants constantly requesting a look. It took about a week for the novelty of the devices to wear out in the school population.

Teachers were only able to perceive any disruption on a large scale. This could possibly because the high level of general disruption already presented in class.

A_R2.0.2 – Support for Teachers

Many teachers expressed the opinion that they (and many of their colleagues) will require support in making use of the mobile medium. They said that they do not feel sufficiently competent with the current technologies being employed at school (use of word processing, report writing, marks compilation with spreadsheets and Web usage). Many questioned their own competency level in deploying any new technologies.

A_R2.0.3 – Access Control Issues

Many teachers raised concern as to how access control of the devices and external content access by the students. Currently the teachers rely on watching the screens of the computers to ensure students are working. If students are using the smaller mobile devices, the concern is that the teachers will not be able to monitor usage in this way. Internet-based content was raised as a major concern.

A_R2.0.4 – Loss and damage to devices

No PDAs were lost but one spare stylus was not returned. No noticeable damage was done to any PDAs. All were received back in working order.

It was noted during the interviews that both students and educators were very security-conscious and as a result took great care of the devices. The fact that no devices were lost was encouraging.

A.4.3 Relating to Objective A_O3.0

Collect ideas on how the mobile medium and devices could be used in and out of the classrooms - including usage, device & other related information

A_R3.0.1 – Bluetooth

A pair of students tried to use Bluetooth as a means to share information. Other students and some teachers also suggested that its short range could be use to share resources with in the classroom. Resources such as multimedia content can be shared in an ad-hoc manner.

A_R3.0.2 – Internet and Network Usage

Many participants noticed the absence of Internet and Intranet access. The school as an intranet site which many wanted to access. Many students also mentioned web-based research as the reason for wanting Internet access. The school has started to explore content provision via a Learning Management System - (Moodle)– see A_R3.0.3 – Resources Provided by Teachers.

Teachers were also concerned with controlling access to external sites (see A_R2.0.3 – Access Control Issues).

Two students managed to connect to the Internet via wifi at home.

A_R3.0.3 – Resources Provided by Teachers

The school has started to put class content (notes, exercises, past papers) on Moodle and participants were keen on having similar content accessible on the mobile medium. Teachers also envisaged an idea of a library of resources where students can access relevant information to the class.

A_R3.0.4 – Text-based and Multimedia Content

When questioned on specific type of information that should be provided, students and teachers agreed on multimedia content such as videos and audio. They also mentioned that text-based information similar to those found in textbooks should also be available on the mobile medium.

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A.5 Interviews

Issues mentioned by the teachers that require further clarification were:

- Priority for technology integration and resources allocation for various aspects of running a school
- Past experience with technology integration and how they felt about it
- General view on the mobile technology for use in education

Interviews were conducted with the Head of Academics of the school that participated in the preliminary study at the conclusion of the study. Similar interview was also conducted with principals of another high school in the Cape Town area.

Interview 1

Participant Profile: Head of Academics at a State School (Same as for Preliminary Study)

Date: 22 May 2007

Priority for Technology Integration & Resource Allocation:

- There is no budget specifically allocated by the school for technology integration.
- Khanya project is the only on-going project that involved integration of technology in education and it is driven externally by the WCED.
- Teachers are encouraged to make use of technology in their classroom. Head of departments were also free to allocate part of their budget for this purpose. Some of the teachers are doing good work with the smartboard provided by the Khanya Project. However, most teachers are not confident in making use of the technology.
- There are limited number of computers and time slots which were allocated to teaching computer-literacy and the subject of Computer Applications Technology (CAT which involves using applications such as Office). Teachers are able to make use of the computer rooms when they are not being used for these subjects.
- There are more pressing issues than technology integration including payment for students attending on the no-fee basis, maintenance of existing infrastructure, and human resources (hiring more teachers). Being a state school, part of the budget comes from the state but the school also part of its

funding from fees and donation. The school's governing body is responsible for the budgeting and most of it does not go into technology integration.

- Technology integration is something that the school would like to do but there are financial constraints. The Khanya project is still on going and, at this stage, represents the school's integration effort.

Past experience with technology integration and how they felt about it

- Experience with integration with Khanya has not always been positive – although the school is very grateful for the opportunity to take part in such project. The school has not been kept in the loop as to what is happening and the support is not always there when needed.
- The school IT technician has reported that the school's existing infrastructure (which is Linux-based) has not been taken into account by the Khanya whose system works on Windows. Support has also not been available within the agreed time frame in many cases. In one case, a broken LCD screen, still under manufacturer's warranty, was left unfixed for more than a month. The school technician was responsible for passing on software-based queries to Khanya but in his report has indicated that this model is not ideal as it requires too many people in the chain and there's an inherent delay for queries that require near immediate solution.
- Teachers have also reported that resources provided by Khanya were often not in line with what they want to teach in the classroom, while some were provided without training for the teachers. Where training sessions were offered, many teachers were not able to make it to make them due to other commitments. The school has suggested that the sessions be scheduled prior to the start of each year so that it can incorporate into the school's calendar. This will ensure that teachers are not committed to other school activities at those times.

Their general view on the mobile technology for use in education

- The school bans the use of mobile phone in the classroom because the majority of teachers felt that they are distractions in class.
- The school feels that there is great potential for the use of the medium to supplement the teaching in and out of class and is willing in principal to allow for use of such devices during class if the distraction can be reduced (e.g. in flight mode).
- Students are much more verse in using the relatively new mobile phones – more so than adults. Teachers will need to be confident enough to make use of any related technologies especially if students are to use them in class. Specific issues include ensuring that students are not using the device for other purpose other than educational.

Interview 2

Participant Profile: Principal of a Private High School

Date: 13 August 2007

Priority for Technology Integration & Resource Allocation

- The school and its parent company support technology integration in principle but there is currently no budget allocation specifically for integration of any new technology for the school. However, should a project be proposed by teachers it will be seriously considered by the school management structure as well as that of the parent company, should that level of involvement be required. The parent company also has a dedicated IT department that is exploring new usage of technology and have introduced new software, hardware and training in the past.
- ICT equipment such as projectors and smartboards are provided in classroom on a ongoing basis with an average of 1 smartboard and 3 projectors per year being installed in the classroom. Although, the budget allocation for ICT equipment is higher than in state schools but most of it goes towards the purchasing and running of the computer-based subject such as Information Technology (IT) and Computer Application Technology (CAT). As smaller proportion of the budget goes towards purchasing ICT equipment used for teaching. Also, in tough economic times this portion of the budget is often the first to cut back as other essential items are kept. Essential items include staff salary, maintenance of equipment and provision of service required for teaching.

Past experience with technology integration and how they felt about it

- The school is dependent on the parent company to drive any introduction, training and support of new technology. In the past, the parent company's IT department has even chosen the computers for use in the classroom with little consultation of the teachers concerned.
- The school has a contract with an external provider for ICT support and as such any additional ICT project from within the school would require additional support personnel.
- Teachers have raised concerns with level of training provided in the most recent introduction of new software (an administrative software that keep track of student's information, contact detail, marks, subjects and reports). Training was only provided to a handful of teachers because it was not well

planned and was scheduled for the times that were not suitable for teachers to attend.

- Prior to the introduction of the software package, no consultation was done with the teachers or the school. It was recommended for use by all schools run by the parent company. They were told that this would simplify the support for the software as everyone is running the same system.
- In the first evaluation of the software (anonymous questionnaire) conducted by the school, a common concern was that the software force them to completely change the way things were done and often not for the better. This further highlights the lack of consultation.
- Despite this premise, support for the software is based in Johannesburg – a city that is more than 2000km away. As a result there were no face to face contact and communications is done on the phone or via emails. The support is also delayed and some requests for modification of software take much later or not at all – for requests which are made by just the school.

Their general view on the mobile technology for use in education

- The school bans the use of mobile phone by the student in class unless it is permitted for use by the teachers. For example, some students were allowed to use their phone to listen to music during art and design classes. Teachers are able to allow students to make use of any electronic devices in their class. This demonstrates that the school supports the use of mobile and other technology as long as it is beneficial to the teaching and learning.

University of Cape Town

Appendix B: Mobile Device Survey

B.1 Objectives of the Study

To conduct a survey across broad sample of schools to find out the following information.

- [Bo1.0] Discover family policy on mobile devices used by students
- [Bo2.0] Discover current capability and trend of mobile phones used by students
- [Bo3.0] Discover whether or not students and teachers have access to computer with Internet connectivity from school and home

After the PDA study (Study A), we also have additional objectives as follows:

- From AR3.0.1: We need to find out if Bluetooth capability is available on mobile phones as well as explore how it is being.
 - [Co1.0] – Discover usage level of Bluetooth with students and teachers
- From AR3.0.2: We need to find out if Wi-Fi capability is available on mobile phones as well as explore how it is being used and can be used..
 - [Co2.0] – Discover usage level of Wi-Fi with students
- From AR3.0.3 & AR3.0.4: We need to find out they types of information that can be provided by teachers. The starting point of this question was from the interviews conducted with teachers and students in the first PDA study.
 - [Co3.0] – Discover types of information that may be suitable for the mobile medium including video, audio and text-based. Many of the suggestions of suitable types have suggested by the teachers and students in Study A.
- From AR3.0.3: Class disruptions by mobile phones were something that most schools have dealt with by implementing a ban. However, there are many different ban and the reasons for them. We need to find out more about what is allowed and when.
 - [Co4.0] – Usage of mobile devices in education during class

B.2 Design of the Survey

B.2.1 Participant Groups

Two distinct groups of participants were used – teachers and students of local high schools in the Cape Town area.

B.2.1.1 School Profiles and Number

Four distinct profiles of schools (six schools in total) took part in the survey. They were chosen to reflect the socio-economic landscape of South Africa:

Middle class co-educational state schools (Two): One of the two schools took part in Study A. In that school, there were 1189 students and 33 teachers. We received 52 responses from students and 8 from teachers. In the other school, there were 856 students and 38 teachers. We received 35 responses from students and 7 from teachers.

Township co-educational state school (One): The school had 1635 learners and 53 teachers. We received 65 responses from students and 9 from teachers.

Non-uniform wearing co-educational private school (Two): *The two schools involved belong to the same group and essentially have the same policies and structures. They are however located in different areas of Cape Town. In one school there were 238 learners and 25 teachers. We received 38 responses from learners and 18 responses from teachers. In the other schools, there were 452 students and 40 teachers. From this school, we received 42 responses from students and 11 responses from teachers.*

Girls-only Private School: There were 225 students and 25 teachers in the high school section of this school. We received 25 responses from students and 11 from teachers.

B.2.1.2 Summary of Participant Make-up

Figure 3.1: Survey Participants Distribute by School Type shows the makeup of participants in the two groups.

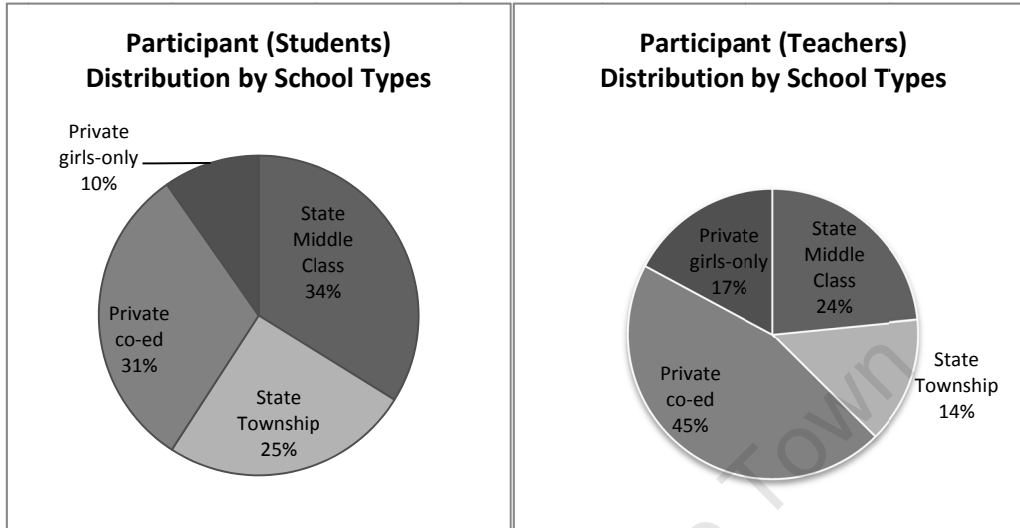


Figure B.1: Survey Participants Distribution by School Types (Left: Students, Right: Teachers)

B.2.2 Distribution Methods

The survey was distributed using two methods:

Printed form: Survey forms were printed and given to a teacher volunteer to distribute at his/her school. The staff survey forms were then left in the staffroom for teacher to complete. The survey forms were collected after 4 weeks. Volunteer teachers also asked the teachers to double check and every question has been answered.

Electronic form: Spreadsheet version of the survey were produced and given to CAT (Computer Application Technology) or Computer Literacy teachers who facilitated the data collection process. As part of an exercise for the subject, CAT/Computer Literacy students are required to survey students from the school and complete one spreadsheet per participant. They also consolidated their data into one spreadsheet. When students collected the data, participant's names were noted down to ensure that no students were surveyed twice. However, this information is removed during the consolidation process. All of the data in the student survey were collected in this way. Each group had three weeks to collect

their data and another to consolidate them. The overall student surveying process took over three months as different classes started their survey at different times.

B.2.3 The Questions

There were two sets of questions – for students and teachers. The two sets were based on the same 21 questions shown in Table B.11. The table indicates the questions, the objectives linked to each question as well as whether the question was used in the student survey, the teacher survey or both.

Table B.1 - Questions used in the Mobile Phone Survey (Study B & C). The last two columns indicated whether the question was used in the student survey, the teacher survey or both.

No	Objectives	Question	Students Survey	Teachers' Survey
1	<ul style="list-style-type: none"> [Co4.0] - <p>The usage of mobile devices in education during class</p>	<p>My School has the following cellphone policies</p> <ol style="list-style-type: none"> 1. Students may not bring mobile phones to school at all 2. Students can only use mobile phones at break time and after school. 3. Students can only use mobile phones after the school. 4. Other – specify: 	<input type="checkbox"/>	<input type="checkbox"/>
2	[Bo3.0] - discovering more information about the current capability of mobile phones and the family policy around their usage at home	<p>I have access to a computer with Internet</p> <ol style="list-style-type: none"> 1. Only at home 2. Only at school 3. At both home and School 4. Not at all 5. I'm not sure 	<input type="checkbox"/>	<input type="checkbox"/>
3S	[Bo1.0] - discovering more information about the current capability of mobile phones and the family policy around their usage at home	<p>My parents/guardian allow me to use my cellphone at home</p> <ol style="list-style-type: none"> 1. at any time I want 2. only when I am not working 3. only when I ask them 4. only at a particular time - specify 5. I'm not allowed at all 6. I don't have a cellphone 	<input type="checkbox"/>	<input type="checkbox"/>

4S	[Bo1.0] - discovering more information about the current capability of mobile phones and the family policy around their usage at home	When I run out of airtime 0. my parents will top up for me 1. I will top up with my own money 2. I don't top up until the next month 3. I never run out and I am on prepaid 4. I am on contract	<input type="checkbox"/>	<input type="checkbox"/>
4T	[Bo1.0] - discovering more information about the current capability of mobile phones and the family policy around their usage at home	When I run out of airtime 1. I will top up 2. I don't top up until the next month 3. I never run out and I am on prepaid 4. I am on contract	<input type="checkbox"/>	<input type="checkbox"/>
5	[Bo1.0] - discovering more information about the current capability of mobile phones and the family policy around their usage at home [Bo2.0] - Discover current capability and trend of mobile phones used by students	To save money I'd rather send 1. SMS 2. Mxit Message 3. I don't worry about money - just make calls 4. Other - specify	<input type="checkbox"/>	<input type="checkbox"/>

6-16	<p>[Bo2.0] - Discover current capability and trend of mobile phones used by students</p> <ul style="list-style-type: none"> [Co1.0] - . <p>The usage level of Bluetooth with students and teachers</p> <ul style="list-style-type: none"> [Co2.0] - <p>The usage level of Wi-Fi with students</p> <p>[Co3.0] - Preliminary Study (Appendix A).</p> <p>These objectives were to discover:</p> <p>The types of information that may be suitable for the mobile medium including video, audio and text-based</p>	<p>My phone can [6: Play songs], [7: Play Videos], [8: run MXiT], [9: send/receive SMS], [10: access the Web], [11: has Bluetooth], [12: has wifi], [13: has 3G], [14: take photos], [15: take videos], [16: has enough space for songs/videos etc]</p> <ol style="list-style-type: none"> 1. Yes 2. No 3. Not sure <p><i>Note: Questions 6-15 have the same basic structure but with the words in square brackets [] appearing for each question as indicated above.</i></p>	□	□
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17-19	<ul style="list-style-type: none"> • [Co1.0] - . <p>The usage level of Bluetooth with students and teachers</p> <ul style="list-style-type: none"> • [Co2.0] - <p>The usage level of Wi-Fi with students</p> <p>[Co3.0] - Preliminary Study (Appendix A).</p> <p>These objectives were to discover:</p> <p>The types of information that may be suitable for the mobile medium including video, audio and text-based</p>	<p>I use [17: Bluetooth], [18: wifi], [19: Internet] on my mobile phone</p> <p>Tick all applicable</p> <ol style="list-style-type: none"> 1. Often to transfer files - specify type: 2. To access the Internet 3. Cant remember what I used it for 4. Others - specify 5. I never use it for anything 6. My phone doesn't have it / Not sure if I have it <p><i>Note: Questions 17-19 have the same basic structure but with the words in square brackets [] appearing for each question as indicated above.</i></p>	<input type="checkbox"/>	<input type="checkbox"/>
20S	<p>[Co3.0] - Preliminary Study (Appendix A).</p> <p>These objectives were to discover:</p> <p>The types of information that may be suitable for the mobile medium including video, audio and text-based</p>	<p>Rate from 1 – 5 (1 useless, somewhat useless, indifferent, useful, very useful) for how useful/useless the following information will be if available on your cellphone</p> <ol style="list-style-type: none"> 19S.1. Homework information (info & due dates) 19S.2. Test information and important dates 19S.3. Notes / Textbooks 19S.4. Help from teachers 19S.5. Videos / Podcast of class 	<input type="checkbox"/>	<input type="checkbox"/>

20T1	<p>[Co3.0] - Preliminary Study (Appendix A). These objectives were to discover:</p> <p>The types of information that may be suitable for the mobile medium including video, audio and text-based</p>	<p>Rate from 1 – 5 (1 useless, somewhat useless, indifferent, useful, very useful) for how useful/useless the following information will be if available to your students on their cellphone</p> <p>20T1.1. Homework information (info & due dates)</p> <p>20T1.2. Test information and important dates</p> <p>20T1.3. Notes / Textbooks</p> <p>20T1.4. Help from teachers</p> <p>20T1.5. Videos / Podcast of class</p>	<input type="checkbox"/>	<input type="checkbox"/>
20T2	<p>[Co3.0] - Preliminary Study (Appendix A). These objectives were to discover:</p> <p>The types of information that may be suitable for the mobile medium including video, audio and text-based</p>	<p>Rate from 1 – 5 (1 useless, somewhat useless, indifferent, useful, very useful) for how useful/useless the following information will be if available to your students' parents on their cellphone</p> <p>20T2.1. Homework information (info & due dates)</p> <p>20T2.2. Test information and important dates</p> <p>20T2.3. Notes / Textbooks pages</p> <p>20T2.4. Help from teachers</p> <p>20T2.5. Videos / Podcast of class</p>	<input type="checkbox"/>	<input type="checkbox"/>
21	<p>[Co3.0] - Preliminary Study (Appendix A). These objectives were to discover:</p> <p>The types of information that may be suitable for the mobile medium including video, audio and text-based</p>	<p>Any concerns about providing each type of information?</p> <p>21.1. Homework information (info & due dates)</p> <p>21.2. Test information and important dates</p> <p>21.3. Notes / Textbooks</p> <p>21.4. Help from teachers</p> <p>21.5. Videos / Podcast of class</p>	<input type="checkbox"/>	<input type="checkbox"/>
22	Any other comment		<input type="checkbox"/>	<input type="checkbox"/>

B.3 Findings and Analysis

The full results and graphs are available in Appendix B: Qualitative Data from Mobile Phone Survey (Study B & C). All teachers surveyed had a mobile phone. Students who took part in the survey all had mobile phones. The number students who did not have a mobile phone were also recorded and there were 10 such students (compare to 257 with at least one). The results of the survey presented here and in the Appendix only included those with mobile phones.

B.3.1 Relating to Objective B_O1.0

discovering more information about the current capability of mobile phones and the family policy around their usage at home

B_R1.0.1 – Use of Cellphone at home

The majority of parents permit their children usage of mobile phone at home with some control in some cases (Question 3S).

B_R1.0.2 – Cost and Financial factor

Most students are either on contract (postpaid account) or on a prepaid contract which parents are willing to top up when depleted. About 90% of the students will always have access to a connected mobile phone (Question 4S). Some students Cost clearly is a factor for most students – with 92.6% of them resorting to use of cheap chat services such as MXit and to a much lesser extend SMS. (Question 5).

B.3.2 Relating to Objective B_O2.0

Discover current capability and trend of mobile phones used by students

B_R2.0.1 – MXiT Capability

Most students' phones (88.3%) are capable of running a chat service called MXiT (Question 8S). 70.8% of them would rather send messages over MXiT to save on communication cost (Question 5S).

B_R2.0.2 – Limited Data Storage

Most students (49.0% of students¹⁸) felt that they do not have enough space on their phone to store data such as music and videos. (Question 16S).

B_R2.0.3 – Camera-equipped Mobile Phone

Some of the students have mobile phone that are equipped with camera that can take photos (44.4% - Question 14S) and videos (37.7% - Question 15S).

B_R2.0.4 – SMS Capability

Almost 99.2% of students' mobile phones are capable of sending and receiving SMS (Question 9S).

B_R2.0.5 – Multimedia Handling Capability

Most phones are able to handle multimedia content – with 74.7% able to play music (Question 6S) but only 35.0% were able to play video (Question 7S). Multimedia usage may be hampered by insufficient storage space (B_R2.0.2).

B_R2.0.6 – Data Connectivity

Most students have Bluetooth-capable phone (57.6% - Question 11S). Only 6.2% has wifi-capable device (Question 12S) and 10.5% has 3G connectivity (Question 13S).

B.3.3 Relating to Objective B_O3.0

Discover whether or not students and teachers have access to computer with Internet connectivity from school and home

¹⁸ With 34.2% saying they do have enough and 16.7% not sure.

B_R3.0.1 – Internet Access for Students and Teachers

All schools in the study have Internet access (Question 2S & 2T). 43% of students and 67% of teachers have access to Internet-connected computer at home.

B.3.4 Relating to Objective Co1.0

- .

The usage level of Bluetooth with students and teachers

C_R1.0.1 – Current Bluetooth Usage

Bluetooth is used to transfer files (27.2% of students and 15.6% of teachers) – mainly contact detail as well as photos. The other use of Bluetooth is to connect headsets (indicated under others) – Question 17S & 17T.

- B.3.5 Relating to Objective Co2.0

The usage level of Wi-Fi with students
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C_R2.0.1 – Current Wi-Fi Usage

With a low number of students and teachers with Wi-Fi connectivity on their phones, the usage varied. A lot more student has tried to use Wi-Fi to access the Internet. Most teachers with Wi-Fi have not used it for anything. (Question 18S & 18T).

B.3.6 Relating to Objective Co3.0

Preliminary Study (Appendix A). These objectives were to discover:

The types of information that may be suitable for the mobile medium including video, audio and text-based

C_R3.0.1 – Notes and Textbook

Both students and teachers thought that having notes available on the student's mobile phone would be useful. On the scale of 1-5 (1- useless, 3 Indifferent to 5 very useful), the students gave an average of 4.58 (Question 20S.3) and teachers gave an average of 3.20 (Question 20T1.3). The teachers gave an average score of 2.08 when asked if this would be useful to parents (Question 20T2.3). Teachers do have some concern on how this can be provided for the students as well as some copyright issues (Question 20.1)

C_R3.0.2 – Homework/Test Information and Important Dates

This idea was well-received by the students (Homework 4.77 average – Question 20S.1 and Test/Important Information 4.82 average – Question 20S.2) and teachers (4.56 average – Question 20T1.1 and Test/Important Information 4.61 average – Question 20T1.2). The teachers also thought that this would also be useful for parents to receive (Homework 4.27 average – Question 20T2.1 and Test/Important Information 4.72 – Question).

C_R3.0.3 – Exercise

Students and teachers suggested that exercises should be provided. Some automarking similar to Moodle's quiz functionality was also suggested (Question 21).

C_R3.0.4 – Live Help

Although, most students thought that this would be useful (4.59 average – Question 20S.4), most teachers did not think that this would be useful (2.38 average – Question 20T1.4). The reason for this was that a lot of the teachers can not see how they will have enough time in their busy schedule to make this work (Question 21.4). They also did not think that live help would be useful to parents (Question 20T2.4) – since it is the student who will be needing help (Question 21.4).

C_R3.0.5 – Video/Podcast of class

Most students did not think that this would be that useful (2.92 average – Question 20S.5). Many of the teachers thought that this would be useful to be provided to students (3.67 average – Question 20T1.5). A few thought that this would be useful when students were absent or did not understand the content in class the first time. Some also expressed concerns on the technical aspects of providing the content as well as privacy issue (Question 21.5). For this reason, most also did not think it would be useful for parents (1.28 – Question 20T2.5).

C_R3.0.6 – Powerpoint Slides

It was suggested by five teachers that powerpoint slides being made available to students would be useful. (Question 22).

C_R3.0.7 – External Web Resources

Another suggestion from teachers was that external web resources such as Wikipedia should be available for teachers to point of resources to students (Question 22).

- B.3.7 Relating to Objective Co4.0

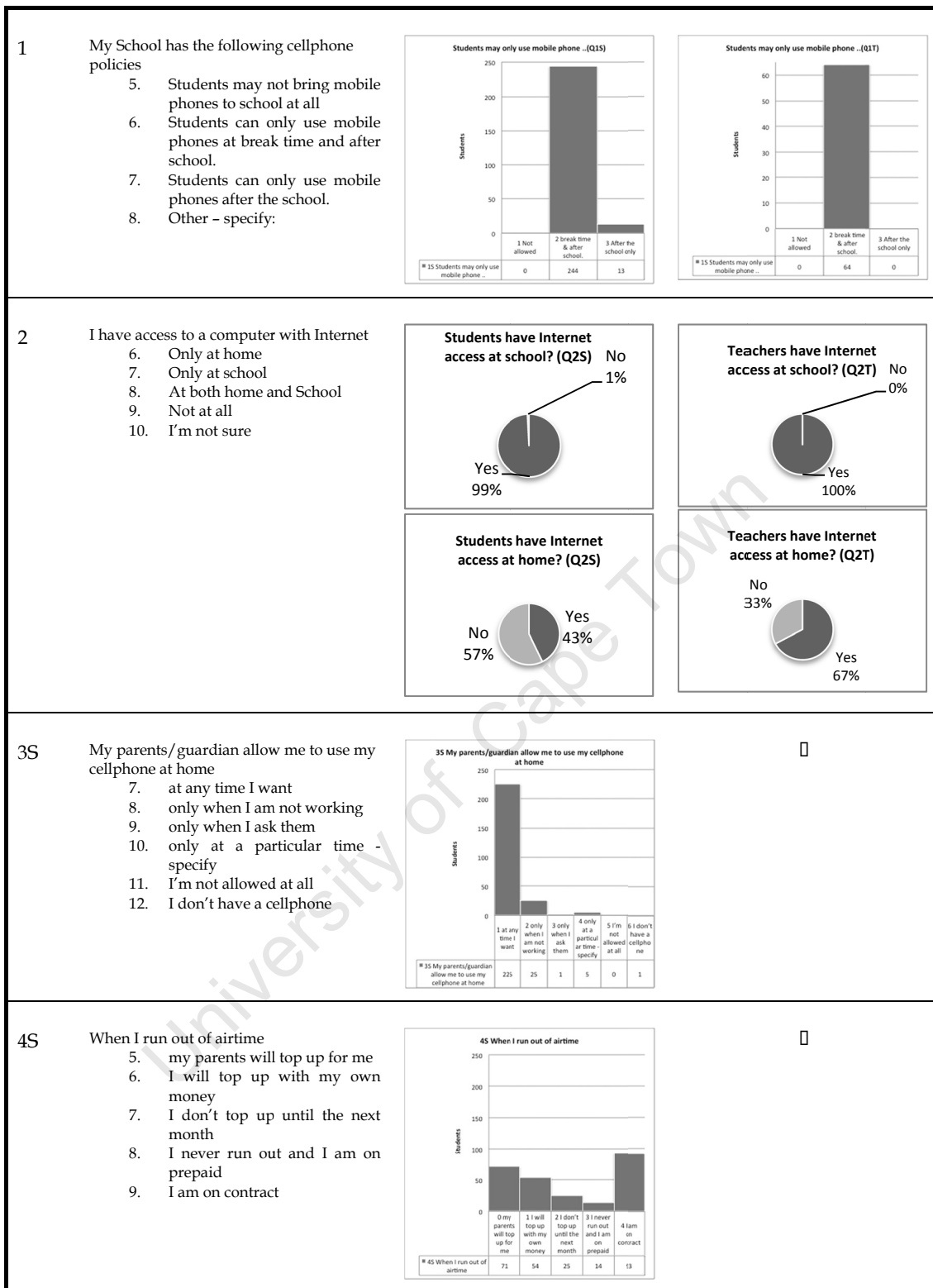
The usage of mobile devices in education during class

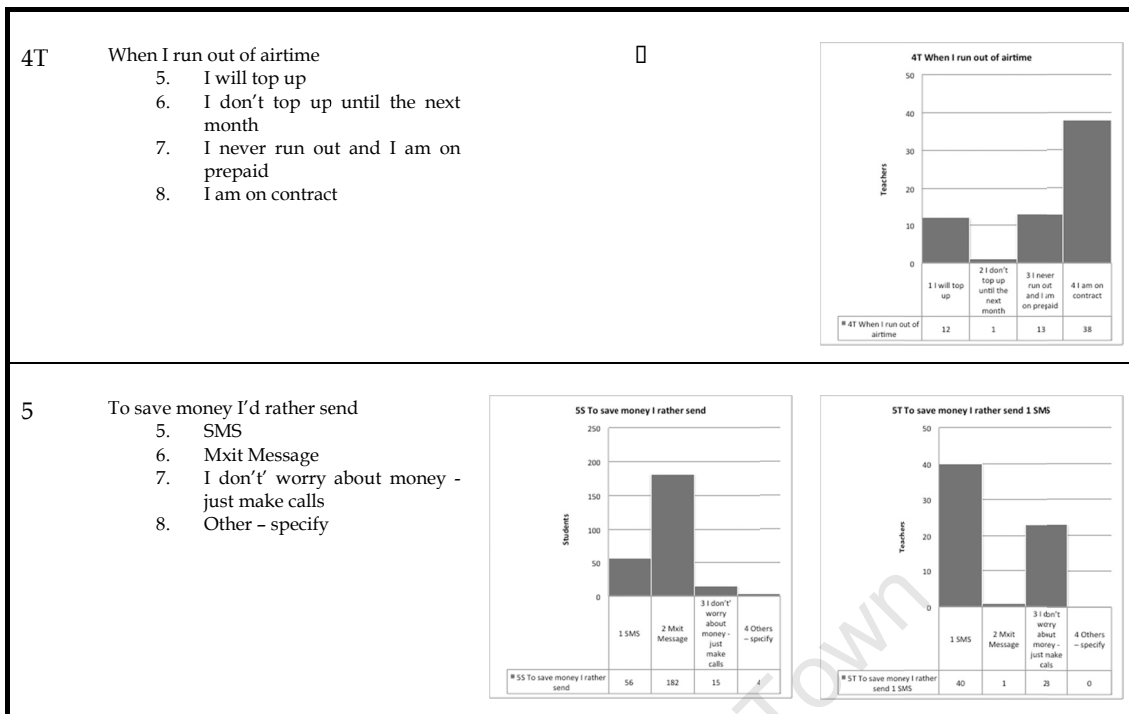
C_R4.0.1 – Mobile devices at school

All schools that took part in the survey allowed students to make use of mobile phones during break time or after school but ban them during class time. In the comment sections, some teachers felt that this is necessary and some conceded that the main concern is the potential of the device to distract students (communications, game etc).

B.4 Quantitative Results

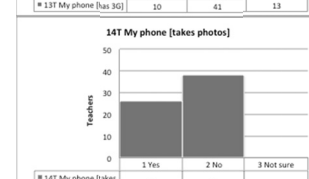
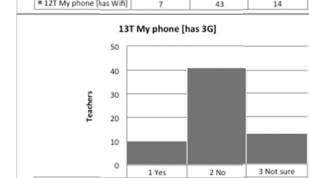
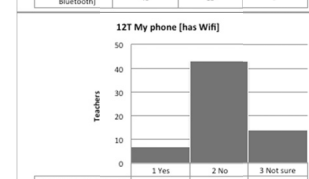
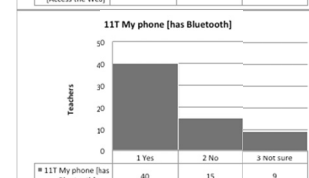
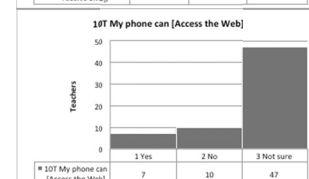
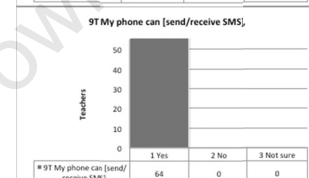
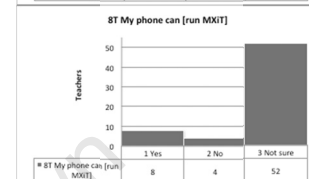
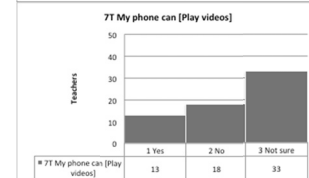
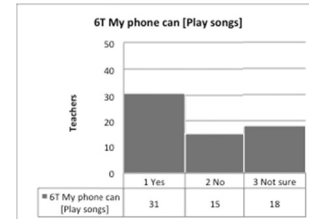
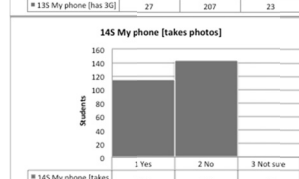
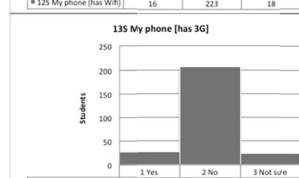
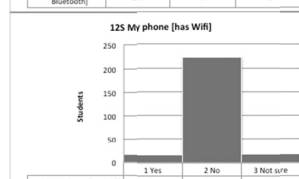
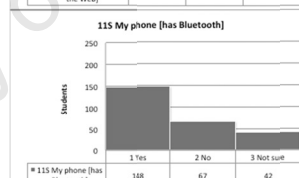
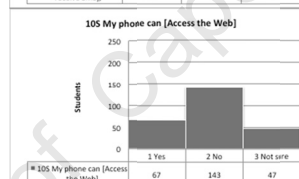
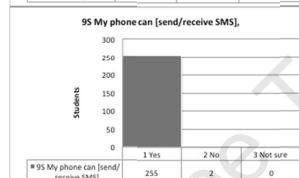
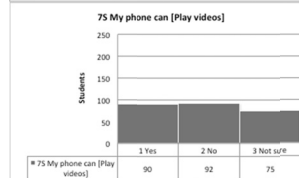
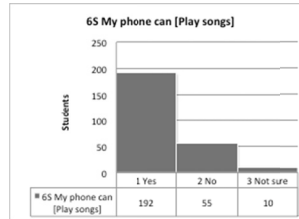
No	Question	Students' Survey	Teachers' Survey
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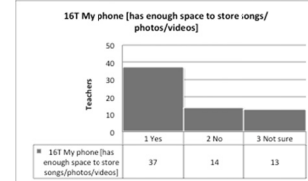
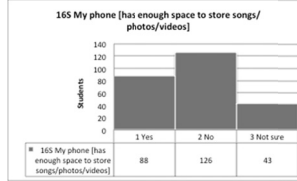
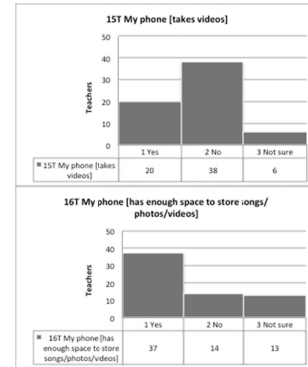
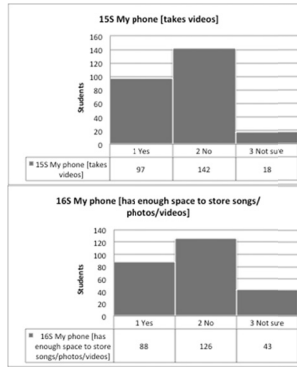


- 6-16 My phone can [6: Play songs], [7: Play Videos], [8: run MXiT], [9: send/receive SMS], [10: access the Web], [11: has Bluetooth], [12: has wifi], [13: has 3G], [14: take photos], [15: take videos], [16: has enough space for songs/videos etc]
4. Yes
 5. No
 6. Not sure

Note: Questions 6-15 have the same basic structure but with the words in square brackets [] appearing for each question as indicated above.



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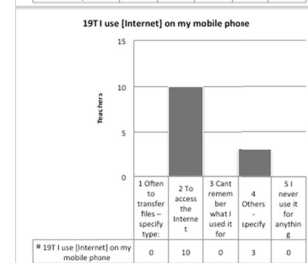
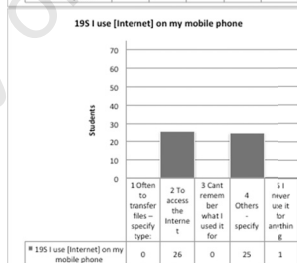
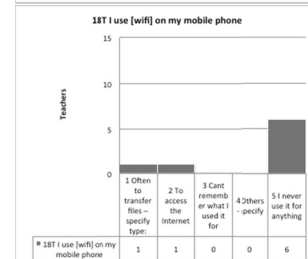
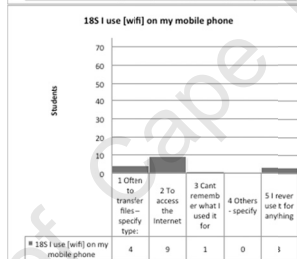
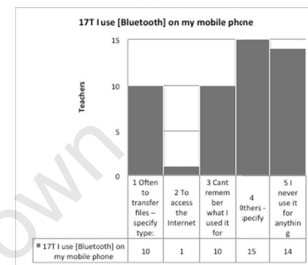
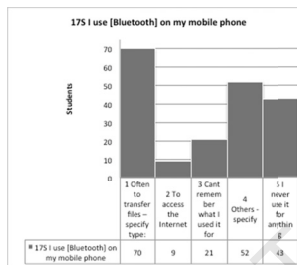


17-19 I use [17: Bluetooth], [18: wifi], [19: Internet] on my mobile phone

Tick all applicable

7. Often to transfer files - specify type:
8. To access the Internet
9. Cant remember what I used it for
10. Others - specify
11. I never use it for anything
12. My phone doesn't have it / Not sure if I have it

*Note: Others - specified
Bluetooth: Connect headphone/external devices*

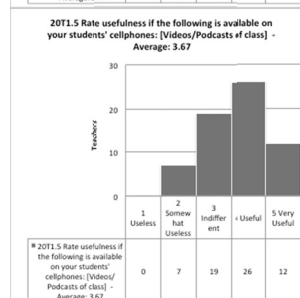
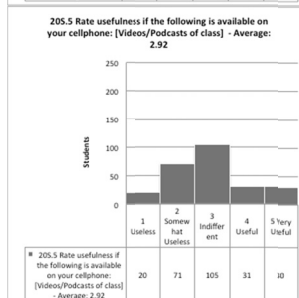
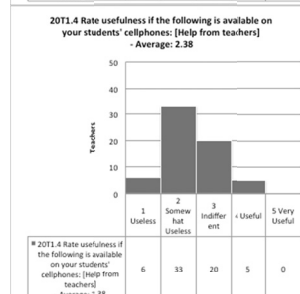
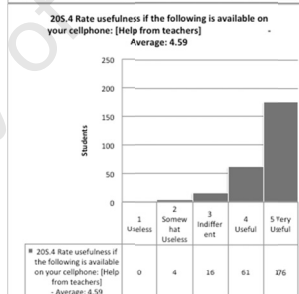
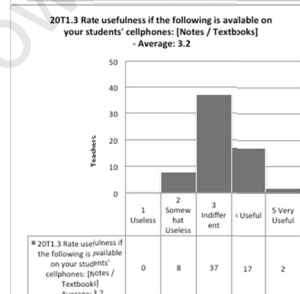
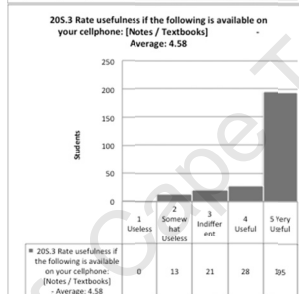
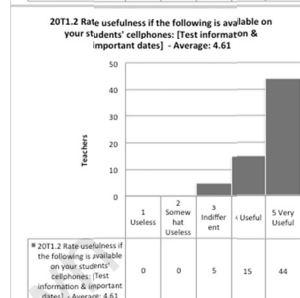
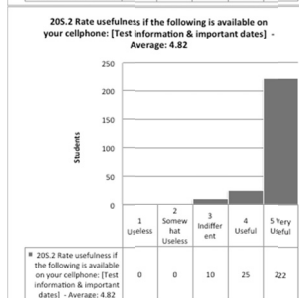
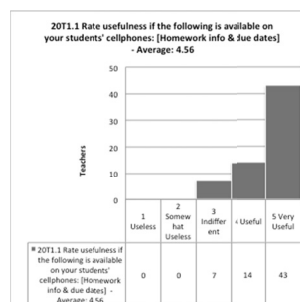
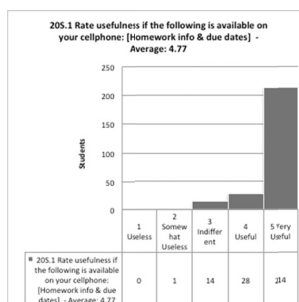


20S Rate from 1 – 5 (1 useless, somewhat useless, indifferent, useful, very useful) for how useful/useless the following information will be if available on your cellphone

- 20S.1. Homework information (info & due dates)
- 20S.2. Test information and important dates
- 20S.3. Notes / Textbooks
- 20S.4. Help from teachers
- 20S.5. Videos / Podcast of class

20T1 Rate from 1 – 5 (1 useless, somewhat useless, indifferent, useful, very useful) for how useful/useless the following information will be if available to your students on their cellphone

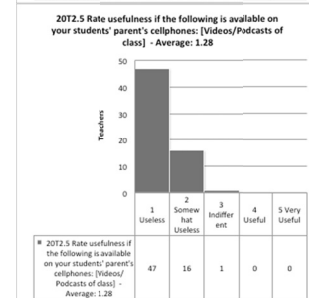
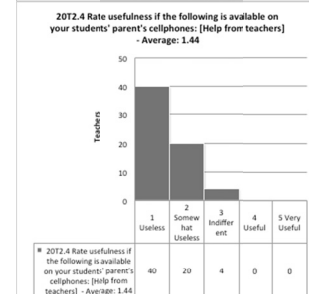
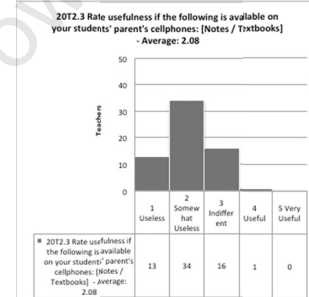
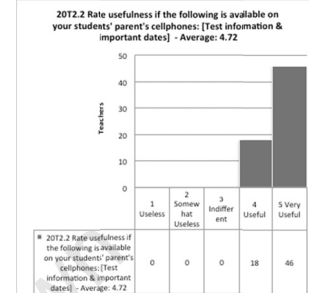
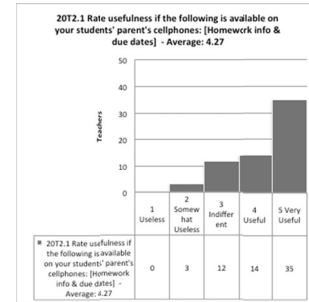
- 20T1.1. Homework information (info & due dates)
- 20T1.2. Test information and important dates
- 20T1.3. Notes / Textbooks
- 20T1.4. Help from teachers
- 20T1.5. Videos / Podcast of class



20T2 Rate from 1 – 5 (1 useless, somewhat useless, indifferent, useful, very useful) for how useful/useless the following information will be if available to your students' parents on their cellphone

- 20T2.1. Homework information (info & due dates)
- 20T2.2. Test information and important dates
- 20T2.3. Notes / Textbooks pages
- 20T2.4. Help from teachers
- 20T2.5. Videos / Podcast of class

□



20 Any concerns about providing each type information?

- 20.1. Homework information (info & due dates)
- 20.2. Test information and important dates
- 20.3. Notes / Textbooks
- 20.4. Help from teachers
- 20.5. Videos / Podcast of class

□

□

21	Any other comment		
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University of Cape Town

Appendix C: School-driven Surveys

C.1 EIS Survey (STF1)

Please complete this survey by the end of the term. The purpose of the survey is to discover issues experienced by teachers after EIS has been running for almost a term. The result will be used to improve the system for next term.

Name: (Optional)															
1. Please indicate how you are currently accessing EIS <i>Tick all relevant methods</i>	<input type="checkbox"/> EIS Machine <input type="checkbox"/> Staff Machine <input type="checkbox"/> Student Machine <input type="checkbox"/> School Laptop <input type="checkbox"/> Private Laptop <input type="checkbox"/> Other: Specify: _____														
2. How useful to you is the system currently? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>Useless</td> <td>Little Use</td> <td>Neutral</td> <td>Useful</td> <td>Very Useful</td> </tr> </table>	1	2	3	4	5	Useless	Little Use	Neutral	Useful	Very Useful	Comment:			
1	2	3	4	5											
Useless	Little Use	Neutral	Useful	Very Useful											
3. How easy to use is EIS? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>Very Difficult</td> <td>Difficult</td> <td>Neutral</td> <td>Easy</td> <td>Very Easy</td> </tr> </table>	1	2	3	4	5	Very Difficult	Difficult	Neutral	Easy	Very Easy	Comment:			
1	2	3	4	5											
Very Difficult	Difficult	Neutral	Easy	Very Easy											
4. Compare to other software/system, how much training did you require to use EIS effectively? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>Much less than average</td> <td>Less than average</td> <td>Average</td> <td>More than average</td> <td>Much more than average</td> </tr> </table>	1	2	3	4	5	Much less than average	Less than average	Average	More than average	Much more than average	Comment:			
1	2	3	4	5											
Much less than average	Less than average	Average	More than average	Much more than average											
5. How involved do you feel with the development of EIS? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>None</td> <td>Little</td> <td>As Expected</td> <td>More than expected</td> <td>Much more than expected</td> </tr> </table>	1	2	3	4	5	None	Little	As Expected	More than expected	Much more than expected	Comment:			
1	2	3	4	5											
None	Little	As Expected	More than expected	Much more than expected											
6. How much adaptation did you have to do to use EIS? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>None</td> <td>Little</td> <td>Average</td> <td>Less than average</td> <td>Much more than expected</td> </tr> </table>	1	2	3	4	5	None	Little	Average	Less than average	Much more than expected	Comment:			
1	2	3	4	5											
None	Little	Average	Less than average	Much more than expected											
7. Compare to your past ICT introduction, how do you feel about how we went about introducing EIS? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>Much worse</td> <td></td> <td>The same</td> <td></td> <td>Much better</td> </tr> </table>	1	2	3	4	5	Much worse		The same		Much better	Comment:			
1	2	3	4	5											
Much worse		The same		Much better											
8. How much support did you need to make use of EIS? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>None</td> <td>Little</td> <td>As Expected</td> <td>More than expected</td> <td>More than expected</td> </tr> </table>	1	2	3	4	5	None	Little	As Expected	More than expected	More than expected	Comment:			
1	2	3	4	5											
None	Little	As Expected	More than expected	More than expected											
9. Suggestions and other comments															

C.2 EIS Survey (STF2)

Please complete this survey by the end of the term. The purpose of the survey is to determine the usefulness and user friendliness of the EIS system. It will be used to determine if the system should be continued to be used next year and how it could be improved the system should its use be continued next year.

Name: (Optional)	
-------------------------	--

Please rate the usefulness of the following aspects of EIS according to the following scale. Please tick NA if you did not make use of that aspect of the system:

1	2	3	4	5
Useless	Not much use	Neutral	Of Some use	Useful

	Tick one of these						Comment
	NA	1	2	3	4	5	
1. Absentee taking							
2. Indication of late-coming							
3. Adding homework, test and other dates							
4. Viewing homework & other info for today							
5. System support by students in your class							
6. One-on-one training of the system							

Please rate the ease of use of the following aspects of EIS according to the following scale. Please tick NA if you did not make use of that aspect of the system:

1	2	3	4	5
Very difficult	Difficult	Neutral or indifferent	Easy	Very Easy

	Tick one of these						Comment
	NA	1	2	3	4	5	
7. Absentee taking							
8. Indication of late-coming							
9. Adding homework, test and other dates							
10. Viewing homework & other info for today							

	Tick one		Comment or Suggestion on how the system could be improved
	YES	No	
11. Do you think EIS should be used again next year?			

C.3 EIS Survey (STD1)

Please complete this survey by the end of the term. The purpose of the survey is to determine the usefulness and user friendliness of the EIS system. It will be used to determine if the system should be continued to be used next year and how it could be improved the system should its use be continued next year.

Name: (Optional)																	
1. Please indicate how you are currently accessing EIS. <i>Tick all relevant methods</i>	<input type="checkbox"/> MXiT <input type="checkbox"/> SMS <input type="checkbox"/> web on computer <input type="checkbox"/> web on mobile phone <input type="checkbox"/> Other: Specify: _____																
2. How useful to you is the reminder service on EIS? <i>Circle only one choice. Choose not applicable or leave blank if you did not use this service</i>	<table border="1"> <tr> <th>NA</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td></td> <td>Useless</td> <td>Little use</td> <td>Neutral</td> <td>Useful</td> <td>Very useful</td> </tr> </table>	NA	1	2	3	4	5		Useless	Little use	Neutral	Useful	Very useful	Comment:			
NA	1	2	3	4	5												
	Useless	Little use	Neutral	Useful	Very useful												
3. How easy to use is EIS over MXiT? <i>Circle only one choice. Choose not applicable or leave blank if you did not use this service</i>	<table border="1"> <tr> <th>NA</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td></td> <td>Very Difficult</td> <td>Difficult</td> <td>Neutral</td> <td>Easy</td> <td>Very Easy</td> </tr> </table>	NA	1	2	3	4	5		Very Difficult	Difficult	Neutral	Easy	Very Easy	Comment:			
NA	1	2	3	4	5												
	Very Difficult	Difficult	Neutral	Easy	Very Easy												
4. How easy to use is EIS over SMS? <i>Circle only one choice. Choose not applicable or leave blank if you did not use this service</i>	<table border="1"> <tr> <th>NA</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td></td> <td>Very Difficult</td> <td>Difficult</td> <td>Neutral</td> <td>Easy</td> <td>Very Easy</td> </tr> </table>	NA	1	2	3	4	5		Very Difficult	Difficult	Neutral	Easy	Very Easy	Comment:			
NA	1	2	3	4	5												
	Very Difficult	Difficult	Neutral	Easy	Very Easy												
5. How easy to use is EIS over web on a desktop? <i>Circle only one choice. Choose not applicable or leave blank if you did not use this service</i>	<table border="1"> <tr> <th>NA</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td></td> <td>Very Difficult</td> <td>Difficult</td> <td>Neutral</td> <td>Easy</td> <td>Very Easy</td> </tr> </table>	NA	1	2	3	4	5		Very Difficult	Difficult	Neutral	Easy	Very Easy	Comment:			
NA	1	2	3	4	5												
	Very Difficult	Difficult	Neutral	Easy	Very Easy												
6. How easy to use is EIS over web on a mobile phone? <i>Circle only one choice. Choose not applicable or leave blank if you did not use this service</i>	<table border="1"> <tr> <th>NA</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td></td> <td>Very Difficult</td> <td>Difficult</td> <td>Neutral</td> <td>Easy</td> <td>Very Easy</td> </tr> </table>	NA	1	2	3	4	5		Very Difficult	Difficult	Neutral	Easy	Very Easy	Comment:			
NA	1	2	3	4	5												
	Very Difficult	Difficult	Neutral	Easy	Very Easy												
7. How involved do you feel with the development of EIS? <i>Circle only one choice</i>	<table border="1"> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> <tr> <td>None</td> <td>Little</td> <td>As Expected</td> <td>More than expected</td> <td>Much more than expected</td> </tr> </table>	1	2	3	4	5	None	Little	As Expected	More than expected	Much more than expected	Comment:					
1	2	3	4	5													
None	Little	As Expected	More than expected	Much more than expected													
8. Suggestions and other comments	 																

C.4 EIS Survey (STF3)

Please complete this survey by the end of the January. The purpose of the survey is to determine if there are any issues with EIS so that they can be fixed as soon as possible.

Name:	
--------------	--

	Tick one			Describe problem if YES. Please indicate applicable venue if you teach in more than one.
	NA	Yes	No	
1. Are you having computer issues in your venue that may prevent you from accessing EIS?				
2. Do you have a problem getting to EIS on your computer?				
3. Do you have a problem logging into EIS?				
4. Are some of your classes missing from the list on EIS?				
5. Are there any inaccuracies with the class lists on EIS (eg missing or extra students)?				
6. Do you have any problem doing absentees or indicating lateness on EIS?				
7. Do you have any problem entering homework, tests and other information for your class on EIS?				

8. Please indicate any other EIS-related problem and issue.

9. Any comments or suggestions on how EIS could be improved?
(Please be honest as this will definitely help)

Appendix D: List of Activities

Activities are listed in chronological order from when they start.

Key to reference numbers:

STF scheduled staff meetings

AHM Ad-hoc meetings

MTM Individual mentor meetings with different students

STD schedule student activities

Activity Reference Number: STF01A

Activity Name: Planning Team Weekly Meeting

Attendees: Planning Team

Part of: Suitable Content Determination

Tasks: Project Information - Integration effort introduction

Input: Technical aspect about working systems by Researcher; Motivation for Local Participations by Researcher; Motivation for multi-phase by Researcher; Issues experienced in past integration by Researcher; Outline of information flow by Researcher; Data from survey by Researcher

Output or Expected Output: Plan

What needed to be done and How:

- Suitable Content Determine - by Planning Team (*Proposed by Researcher, Driven by Planning Team, Other Drivers: -, Other Participants: Planning Team*)
- Suitable Input interface - via T-iterations (*Proposed by Researcher, Driven by Planning Team, Other Drivers: -, Other Participants: Teachers, Students,*)
- Suitable Medium for Delivery and content format - via S-iteration (*Proposed by Researcher, Driven by Planning Team, Other Drivers: -, Other Participants: Teachers, Students*)
- Suitable backend system based in requirement as study progresses (*Proposed by Researcher, Driven by Planning Team, Other Drivers: -, Other Participants: Teachers, Students*)

Activity Reference Number: STF01B

Activity Name: Planning Team Weekly Meeting

Attendees: Planning Team

Part of: Suitable Content Determination

Tasks: Suitable Content Determination

Input: Presentation of Preliminary survey by Researcher; Input from teachers by Researcher; Data from survey by Researcher

Output or Expected Output: Suitable content chosen

What needed to be done and How:

- Reminders of homework, test and other class information will be delivered (*Proposed by Teachers, Driven by Planning Team, Other Drivers: Teachers, Other Participants: Students*)
- T-iterations, S-Iterations and backend design to be done base on feedback (*Proposed by Researcher, Driven by Planning Team, Other Drivers: To be determined, Other Participants: To be determined*)

Activity Reference Number: STF02

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration I

Tasks: VI - Determine suitable input form - paper-based

Input:

Output or Expected Output: Plan

What needed to be done and How:

- Content to be surveyed from teachers in meetings (*Proposed by Deputy, Driven by HOD present, Other Drivers: Other HOD, Other Participants: HOD*)

- Photographs taken of items written on board - cleaners to take photos with phone before erasing board. (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: Head of maintenance, Other Participants: Cleaners*)
- homework diary sample taken - mentors normally examine diary in any case (*Proposed by Deputy, Driven by Grade Head present, Other Drivers: Other Grade heads, Other Participants: Mentors*)
- Form Design Guidelines consultation. Consult teachers who are doing/have done this (*Proposed by Deputy, Driven by Deputy, Form design teacher, Other Drivers: -, Other Participants: Deputy, Form design teacher*)

Activity Reference Number: AHM01

Activity Name: Form Design Meeting

Attendees: IT Teacher, Form Design Teacher, Deputy

Part of: T-Iteration I

Tasks: Determine form design process

Input:

Output or Expected Output: Form Design Guidelines

What needed to be done and How:

- Notes taken (*Proposed by , Driven by , Other Drivers: , Other Participants:)*

Activity Reference Number: STF03

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration I

Tasks: VI - Determine suitable input form - paper-based

Input: Content surveyed by Deputy, Whiteboard content by CAT teacher, Homework Diary by Deputy, Form Design Guideline by Deputy

Output or Expected Output: Form VI

What needed to be done and How:

- Form VI to be designed by teacher with help of deputy (*Proposed by Deputy, Driven by Form Design Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: Form Distribution plan

What needed to be done and How:

- set of 5 Forms need to be printed and distributed each week (*Proposed by Admin Staff, Driven by Admin Staff, Other Drivers: , Other Participants: Other Admin Staff*)

Output or Expected Output: Form Collection plan

What needed to be done and How:

- Each sheet returned by leaving in special pigeon hole daily (*Proposed by Admin Staff, Driven by Admin Staff, Other Drivers: , Other Participants: Admin Staff*)
- Students collect outstanding sheet if necessary (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants: CAT Students*)

Output or Expected Output: Form Capturing plan

What needed to be done and How:

- Forms need to be captured by students into a spreadsheet (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants: CAT Students*)
- CAT teacher will recruit and call meeting with volunteer capturers (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants: IT Teacher, Student*)

Output or Expected Output: Feedback capturing plan

What needed to be done and How:

- Form will have feedback block on reverse - student will also capture this feedback. (*Proposed by Admin Staff, Driven by Form Design Teacher, Other Drivers: , Other Participants: IT Teacher, Student*)

Activity Reference Number: STD01

Activity Name: Form Capturers Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration I

Tasks: Produce Sample Spreadsheet by each student - each will use their own for vI

Input: Sample Form vI by Form Design Teacher

Output or Expected Output: Spreadsheet vI

What needed to be done and How:

- Spreadsheet to be used to capture data - students will examine form and come up with their own individual solution on how to store data (*Proposed by* CAT Teacher, *Driven by* CAT Teacher, *Other Drivers:* , *Other Participants:* CAT Students)
-

Activity Reference Number: STF04

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration I

Tasks: S-Iterations planning

Input: Presentation of data from survey by Researcher; Data from survey by Researcher, Proposed development plan involving Grade II IT students by IT Teacher

Output or Expected Output: S-Iteration Planning & aspects to be investigated

What needed to be done and How:

- Teachers will canvas students' opinion in LO classes, summary will be provided to each grade head and summarised for presentation in the next meeting (*Proposed by* Deputy, *Driven by* Grade Head, *Other Drivers:* Mentors, *Other Participants:* Students)

Output or Expected Output: Development plan

What needed to be done and How:

- Presentation made on development plan + Discussion (*Proposed by* IT Teacher, *Driven by* , *Other Drivers:* , *Other Participants:* IT Students)
-

Activity Reference Number: MTM01

Activity Name: Content delivery interviews by mentors

Attendees: Mentors

Part of: T-Iteration I, S-Iteration I

Tasks: Discussion of what content to be provided over mobile medium

Input: Presentation made in meeting by IT Teacher

Output or Expected Output: Summary of students' opinion

What needed to be done and How:

- Teachers will canvas students' opinion in LO classes, summary will be provided to each grade head and summarised for presentation in the next meeting (*Proposed by* Deputy, *Driven by* Mentors, *Other Drivers:* , *Other Participants:* Students)
-

Activity Reference Number: STD02

Activity Name: Form Capturer Feedback Session

Attendees: CAT Teacher, Volunteer Students

Part of: T-Iteration I

Tasks: Gather feedback from students on data capturing process; Students to proposed common format(s) to be used; Issues with forms to be summarised

Input: Response to feedback from CAT Teacher by CAT Teacher

Output or Expected Output: Summary of issues raised by capturers

What needed to be done and How:

- 1-2 students will be in charge of writing down all the points and produce report (*Proposed by* CAT Students, *Driven by* CAT Teacher, *Other Drivers:* , *Other Participants:* CAT Students)

Output or Expected Output: common format of spreadsheet

What needed to be done and How:

- Students will present their format to the group and motivate - vote will be held the next day (*Proposed by* CAT Teacher, *Driven by* CAT Teacher, *Other Drivers:* , *Other Participants:* CAT Students)

Output or Expected Output: Summary of issues raised by teachers

What needed to be done and How:

- Summary to be produced from feedback (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants:*)

Activity Reference Number: STF05A

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 1/2

Tasks: Evaluation of Form V1

Input: Summary of issues raised by teachers by IT Teacher, Admin Staff; Summary of issues raised by capturers by CAT Teacher; Summary of feedback from admin teachers by Form Design Teacher

Output or Expected Output: Form V2

What needed to be done and How:

- Designing of Form v2 by form design teacher with Deputy (*Proposed by Deputy, Driven by Form Design Teacher, Other Drivers: , Other Participants:*)

Activity Reference Number: STF05B

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 1

Tasks: Sub Medium to be used for delivery

Input: Feedback from students by Grade Heads

Output or Expected Output: Decision on initial submedium to investigate

What needed to be done and How:

- Discussion based on summary (*Proposed by Deputy, Driven by , Other Drivers: , Other Participants:*)

Output or Expected Output: Explore other submedium - SMS - web - based on feedback

What needed to be done and How:

- Discussion based on summary - Phased in once system is able to store and deliver reminders (*Proposed by IT Teacher, Driven by , Other Drivers: , Other Participants: IT Students*)

Output or Expected Output: Development plan

What needed to be done and How:

- Discussion based on IT teacher's presentation (*Proposed by IT Teacher, Driven by , Other Drivers: , Other Participants:*)

Output or Expected Output: Work towards delivery reminders

What needed to be done and How:

- Must wait for inputting system to be ready - Phased in once system is able to store and deliver reminders (*Proposed by IT Teacher, Driven by , Other Drivers: , Other Participants: IT Students*)

Activity Reference Number: STD03

Activity Name: Form Capturers Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 2

Tasks: Students shown Form v2 and update common spreadsheet to fit

Input: Sample Form v2 by Form Design Teacher

Output or Expected Output: Spreadsheet v2

What needed to be done and How:

- Not decided

Activity Reference Number: STD04

Activity Name: MXiT authentication project

Attendees: Grade 11 IT Class

Part of: S-Iteration 1

Tasks: Explore authentication with MXiT as delivery medium

Input:

Output or Expected Output: Authentication procedure

What needed to be done and How:

- Discussion followed by individual write-up (2 lessons discussion + 1 lesson to finalise write-up) (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Students*)
-

Activity Reference Number: STD05

Activity Name: MXiT Programming project

Attendees: Grade 10/11 IT Class, IT Teacher

Part of: S-Iteration 1

Tasks: Explore different MXiT bots to authenticate, deliver notes, ask questions etc.

Input: MXiT Library by IT Teacher

Output or Expected Output: Authentication procedure with MXiT

What needed to be done and How:

- MXiT bots to do various things (Grade 11: one two weeks project + demo + discussion) (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Students*)

Output or Expected Output: Bots that can deliver content

What needed to be done and How:

- MXiT bots to do various things (Grade 10: one one week project + demo + discussion) (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Students*)
-

Activity Reference Number: STD06

Activity Name: Form Capturer Feedback Session

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 2

Tasks: Gather feedback from students on data capturing process; Issues with spreadsheet to be summarised; Issues with forms to be summarised

Input:

Output or Expected Output: Summary of issues raised by capturers

What needed to be done and How:

- 1-2 students will be in charge of writing down all the points and produce report (*Proposed by CAT Students, Driven by CAT Teacher, Other Drivers: , Other Participants: CAT Students*)

Output or Expected Output: Summary of issues with spreadsheet

What needed to be done and How:

- Spreadsheet to be modified appropriately (with help of CAT Teacher) (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants: CAT Students*)

Output or Expected Output: Summary of issues raised by teachers

What needed to be done and How:

- Summary to be produced from feedback (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants:)*
-

Activity Reference Number: STF06

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 2/3

Tasks: Evaluation of Form v2; Adjustment to T-Iteration timeframe

Input: Summary of issues raised by teachers by IT Teacher; Summary of issues raised by capturers by CAT Teacher; Summary of feedback from admin teachers by Form Design Teacher; Technical issues to consider for backend by IT Teacher

Output or Expected Output: Objectives for electronic Form v3

What needed to be done and How:

- Form v3 produced based on Objectives (*Proposed by Form Design Teacher, Driven by Form Design Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: Modification to Form v3 to meet objectives

What needed to be done and How:

- Form v3 to be reproduced as electronic version by IT Club (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club (extramural)*)
 - Backend system to be produced - IT students will create database based on spreadsheet as class assignment (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Class*)
 - Link up of front end to back end - php scripts (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club (extramural)*)
-

Activity Reference Number: STF07

Activity Name: Form V3 Meeting

Attendees: Form Design Teacher, Deputy, IT Teacher, CAT Teacher

Part of: T-Iteration 3

Tasks: Finalise Form V3

Input: Sample Form v3 by Form Design Teacher

Output or Expected Output: Final Form v3

What needed to be done and How:

- Final form v3 approved after discussion (*Proposed by , Driven by , Other Drivers: , Other Participants:)*
-

Activity Reference Number: STD07

Activity Name: MXiT Programming project - discussion

Attendees: Grade 10/11 IT Class

Part of: S-Iteration 1/2

Tasks: Discuss suitability of MXiT and modification

Input: MXiT projects done by students by IT Students

Output or Expected Output: Summary of benefits and suggestions

What needed to be done and How:

- Class discussion after presentation of bots, then fill in spreadsheet to evaluate each bot, they can also write any comment or suggestions (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Students*)
-

Activity Reference Number: STF08

Activity Name: Notes and MCQ Bot evaluation planning

Attendees: IT Teacher, Physical Science Teacher, Mathematic Teacher

Part of: S-Iteration 2

Tasks: Planning for Notes and MCQs bot evaluation

Input: MXiT projects done by students Demo by IT Students

Output or Expected Output: Plan for how evaluation will work

What needed to be done and How:

- Students to demo the bot to teachers - discussion on planning after (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Students*)
 - Determine student participants by teachers from their class (*Proposed by Maths teacher, Driven by Participating Teacher, Other Drivers: , Other Participants: Students*)
 - Getting the required content in the correct format as well as test that will used to examine the knowledge (*Proposed by Maths teacher, Driven by Participating Teacher, Other Drivers: , Other Participants: Students*)
 - Data gathering and measuring results. Usage data will be logged and teachers will provide test result & analysis (*Proposed by Maths teacher, Driven by Participating Teacher, Other Drivers: , Other Participants: Students*)
-

Activity Reference Number: STD08

Activity Name: Database Design Exercise

Attendees: Grade 12 IT Class, IT Teacher

Part of: T-Iteration 3

Tasks: Design and normalise database tables; Design SQL statements to do select, insert, delete & update

Input: Spreadsheet used to capture form v2 by CAT Students

Output or Expected Output: Database tables

What needed to be done and How:

- Examine spreadsheet and produced table in Access - Student received task as practical exercise (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Class*)

Output or Expected Output: SQL codes to select, insert, update and delete table content

What needed to be done and How:

- Produce SQL codes for various action - Student received task as practical exercise (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Class*)

Activity Reference Number: STD09

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: T-Iteration 3

Tasks: Conversion of Access database to MySQL Database; Conversion of Form v3 to electronic format; PHP Code to print & capture data to the database

Input: Access Database by IT Teacher; HTML/PHP lesson by teacher to club (started in previous term) by IT Teacher; SQL codes created by IT class by IT Students

Output or Expected Output: MySQL Database

What needed to be done and How:

- Conversion from Access to MySQL database done prior to lessons (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club*)

Output or Expected Output: HTML version of Form v3; Backend System to display & capture forms

What needed to be done and How:

- 3 Lessons of HTML/PHP/MySQL delivered over the holidays (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Activity Reference Number: STF09A

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 3

Tasks: Logistics of delivering and processing Form v3

Input: Detail on how Form v3 will be delivered and processed by IT Teacher

Output or Expected Output: Distribution plan

What needed to be done and How:

- Forms need to be distributed - Admin Staff will print form at the end of each day and insert in pigeon hole by morning (*Proposed by Deputy, Driven by Admin Staff Head, Other Drivers: , Other Participants: Admin staff*)

Output or Expected Output: Collection Plan

What needed to be done and How:

- Forms need to be collected - Each sheet returned by leaving in special pigeon hole daily (*Proposed by Admin Staff, Driven by Admin Staff, Other Drivers: , Other Participants: Admin Staff*)
- Students collect outstanding sheet if necessary (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants: CAT/IT Students*)

Output or Expected Output: Capturing Plan

What needed to be done and How:

- Forms need to be captured - Students will capture form to spreadsheet (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants: CAT/IT Students*)
- Meeting set up with students capturer - CAT teachers will recruit additional students if required (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants: IT Teacher, Student*)

Output or Expected Output: Feedback Plan

What needed to be done and How:

- Form will have feedback block on reverse - student will also capture feedback
(*Proposed by Admin Staff, Driven by Form Design Teacher, Other Drivers: , Other Participants: IT Teacher, Student*)
-

Activity Reference Number: STF09B

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 2

Tasks: Use of SMS and web to deliver content to student

Input: SMS cost presentation by IT Teacher

Output or Expected Output: Recommendations

What needed to be done and How:

- Discussions (*Proposed by IT Teacher, Driven by , Other Drivers: , Other Participants:)*
-

Activity Reference Number: STF10

Activity Name: Notes and MCQ Bot evaluation content & user loading

Attendees: IT Teacher, Physical Science Teacher, Mathematic Teacher

Part of: S-Iteration 2

Tasks: Content & user loaded; Test system; Finalise test dates

Input: Content and students names by Subject Teachers; Lesson Plan by Subject Teachers

Output or Expected Output: Dates for when system will be launched

What needed to be done and How:

- IT Students have bot already loaded, they will help others to load - 3 days to do this. (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: Students*)
 - Content will be left on the system for 6 weeks (*Proposed by Maths Teacher, Driven by Subject Teachers, Other Drivers: , Other Participants: Students*)
 - Teachers will conduct a discussion session with students after test (*Proposed by Maths Teacher, Driven by Subject Teachers, Other Drivers: , Other Participants: Students*)
 - Results will be forwarded to IT Teacher and discussed at a later date (*Proposed by IT Teacher, Driven by Subject Teachers, Other Drivers: , Other Participants: Students*)
-

Activity Reference Number: STD10

Activity Name: Database modification for login

Attendees: Grade 12 IT Class, IT Teacher

Part of: T-Iteration 3

Tasks: Research login related database design; Design user table; Design SQL statements to do select, insert, delete & update

Input: Database and Network security by IT Teacher

Output or Expected Output: Database tables

What needed to be done and How:

- Examine spreadsheet and produced table in Access - Student received task as practical exercise (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Class*)

Output or Expected Output: SQL codes to select, insert, update and delete table content

What needed to be done and How:

- Produce SQL codes for various action (*Proposed by , Driven by , Other Drivers: , Other Participants:)*
-

Activity Reference Number: STD11

Activity Name: Form Capturers Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 3

Tasks: Students trained to capture Form v3

Input: HTML Form v3 via server by IT Club

Output or Expected Output: Feedback on Form issues

What needed to be done and How:

- Discussion after training conducted by members of IT club who converted the form (*Proposed by* IT Club, *Driven by* , *Other Drivers:* , *Other Participants:* IT Club members, CAT/IT students)
-

Activity Reference Number: STF11

Activity Name: Homework Bot evaluation planning

Attendees: IT Teacher, Physical Science Teacher, Mathematics Teacher

Part of: S-Iteration 2

Tasks: Plan for how homework bot evaluation will happen

Input: MXiT projects done by students Demo by IT Students

Output or Expected Output: Plan for how evaluation will work

What needed to be done and How:

- Seek student volunteer from subset of those taking part in notes - exclude IT & capturers. Science & Maths teacher will ask student to volunteer (*Proposed by* Science Teacher, *Driven by* Maths/Science Teachers, *Other Drivers:* , *Other Participants:*)
 - Class info must be hard coded for those students (*Proposed by* IT Teacher, *Driven by* IT Teacher, *Other Drivers:* , *Other Participants:* Students)
-

Activity Reference Number: STD12

Activity Name: Form Capturers bi-monthly Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 3

Tasks: Evaluate how capturing process is going

Input: HTML Form v3 via server by IT Club

Output or Expected Output: Feedback on Form issues

What needed to be done and How:

- Discussion after session. After data is captured for a few days a discussion is held & summary compiled. (*Proposed by* IT Club, *Driven by* IT Club members, *Other Drivers:* , *Other Participants:* IT Club members)
 - Summary of teacher feedback (*Proposed by* CAT Teacher, *Driven by* CAT Teacher, *Other Drivers:* , *Other Participants:*)
-

Activity Reference Number: STD13A

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: T-Iteration 3

Tasks: Process feedback from teachers and capturers; Capturer Feedback by IT Club; Teachers feedback by CAT Teacher

Input: Database log & Data by EIS

Output or Expected Output: Changes to the EIS

What needed to be done and How:

- Discussion on feedback - IT Club member effect possible changes (*Proposed by* IT Club, *Driven by* IT Club members, *Other Drivers:* , *Other Participants:*)
 - IT Teacher effect changes that are outside of club ability (*Proposed by* IT Club, *Driven by* IT Teacher, *Other Drivers:* , *Other Participants:*)
-

Activity Reference Number: STD13B

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: S-Iteration 2

Tasks: Link of MXiT to EIS

Input: MXiT Bot library by IT Teacher

Output or Expected Output: Link of EIS to MXiT

What needed to be done and How:

- One student from the IT Club and IT teacher worked together to create the link
(*Proposed by IT Club Member, Driven by , Other Drivers: , Other Participants:*)
-

Activity Reference Number: STF12

Activity Name: Reminder service evaluation plan (Mxit & Web)

Attendees: IT Teacher, Physical Science Teacher, Mathematic Teacher

Part of: S-Iteration 2

Tasks: Finalise start date and plan

Input: Volunteer students' timetable by Admin Staff

Output or Expected Output: Dates for when test will be launched

What needed to be done and How:

- volunteer students information must be hardcoded (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)
 - Content will be left on the system for 3 weeks (*Proposed by Maths Teacher, Driven by Subject Teachers, Other Drivers: , Other Participants: Students*)
 - Teachers will conduct a discussion session with students after test (*Proposed by Maths Teacher, Driven by Subject Teachers, Other Drivers: , Other Participants: Students*)
 - Results will be forwarded to IT Teacher and discussed at a later date (*Proposed by IT Teacher, Driven by Subject Teachers, Other Drivers: , Other Participants: Students*)
-

Activity Reference Number: STD14

Activity Name: Form Capturers bi-monthly Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 3

Tasks: Evaluate how capturing process is going

Input: HTML Form v3 via server by IT Club

Output or Expected Output: Feedback on Form issues

What needed to be done and How:

- Discussion after session. After data is captured for a few days a discussion is held & summary compiled (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants: IT Club members*)
 - Summary of teacher feedback (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants:*)
-

Activity Reference Number: STD15A

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: T-Iteration 3

Tasks: Process feedback from teachers and capturers; Addition of login system to EIS

Input: Database log & Data by EIS; Capturer Feedback by IT Club; Database Design with Input by IT Class; SQL statements to do select, insert, delete & update by IT Class

Output or Expected Output: Changes to the EIS

What needed to be done and How:

- Discussion on feedback. IT Club member effect possible changes (*Proposed by IT Club, Driven by , Other Drivers: , Other Participants: IT Club members*)
 - IT Teacher effect changes that are outside of club ability (*Proposed by IT Club, Driven by IT Teacher, Other Drivers: , Other Participants:*)
 - Login system for EIS (*Proposed by IT Teacher, Driven by , Other Drivers: , Other Participants:*)
 - Coding to implement login (PHP & MySQL) (*Proposed by IT Club, Driven by , Other Drivers: , Other Participants: IT Club members*)
-

Activity Reference Number: STD15B

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: S-Iteration 2

Tasks: Hardcoding of volunteered student for reminder service evaluation (Mxit & Web)

Input: Volunteer students' timetable by Admin Staff

Output or Expected Output: Link to homework info for volunteers

What needed to be done and How:

- Link of volunteer and their classes (hardcoded) (*Proposed by IT Teacher, Driven by , Other Drivers: , Other Participants: IT Club members*)
-

Activity Reference Number: STD16

Activity Name: Form Capturer Feedback Session

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 3/4

Tasks: Gather feedback from students on data capturing process; Issues with EIS capturing system to be summarised

Input:

Output or Expected Output: Summary of issues raised by capturers

What needed to be done and How:

- 1-2 students will be in charge of writing down all the points and produce report (*Proposed by IT Students, Driven by IT Students, Other Drivers: , Other Participants:)*

Output or Expected Output: Summary of issues with EIS

What needed to be done and How:

- 1-2 students will be in charge of writing down all the points and produce report (*Proposed by IT Students, Driven by IT Students, Other Drivers: , Other Participants:)*

Output or Expected Output: Summary of issues raised by teachers

What needed to be done and How:

- CAT teacher will summarise issue for presentation (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants:)*
-

Activity Reference Number: STD17

Activity Name: Classroom computer security

Attendees: IT Classes (all grades), IT Teacher

Part of: T-Iteration 4

Tasks: Discussion on classroom security, implementations and what can be done to address them

Input: Network Security talk by IT Teacher

Output or Expected Output: Short essay on issues and preventative measures

What needed to be done and How:

- Student received task as theory exercise (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Class*)
-

Activity Reference Number: ADM02

Activity Name: Various meetings to gather information on security of classroom computers

Attendees: IT Teachers, Various teachers

Part of: T-Iteration 4

Tasks: Discover how teachers are ensuring security of data on their classroom computers

Input: Questions by IT Teacher; Questions raised by students by IT Students

Output or Expected Output: Security practice & concerns

What needed to be done and How:

- Individual discussion (*Proposed by , Driven by , Other Drivers: , Other Participants:)*
-

Activity Reference Number: STF13

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 3/4

Tasks: Evaluation of Form v3 & EIS; Adjustment to T-Iteration timeframe; Summary of feedback from admin teachers by Admin Staff

Input: Summary of issues raised by teachers by CAT Teacher; Summary of issues raised by capturers by IT Teacher; Security concerns from interviews & students assignment by IT Teacher; Equipment to be used for classroom computer by IT Teacher

Output or Expected Output: Changes to Form v3 & EIS

What needed to be done and How:

- Form v3a and EIS changes (*Proposed by* Form Design Teacher, *Driven by* Form Design Teacher, *Other Drivers:* , *Other Participants:*)

Output or Expected Output: Classroom computers specification

What needed to be done and How:

- Discussion at meeting - derived general specs & IT club to work out detail (*Proposed by* IT Teacher, *Driven by* IT Teacher, *Other Drivers:* , *Other Participants:* IT Club (extramural))

Output or Expected Output: List of security recommendations for teachers

What needed to be done and How:

- Discussion at meeting - CAT teacher will produce recommendation (*Proposed by* CAT Teacher, *Driven by* CAT Teacher, *Other Drivers:* , *Other Participants:*)

Output or Expected Output: Guidelines on passwords

What needed to be done and How:

- Discussion at meeting - IT Teacher will produced recommendation (*Proposed by* IT Teacher, *Driven by* IT Teacher, *Other Drivers:* , *Other Participants:* IT Club (extramural))

Output or Expected Output: Hardware and software support plan

What needed to be done and How:

- Discussion at meeting - use capturers for software support & IT club for hardware (*Proposed by* IT Teacher, *Driven by* IT Teacher, *Other Drivers:* , *Other Participants:* IT Students)

Activity Reference Number: STD18

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: T-Iteration 4

Tasks: Explore various Operating system & Kiosk mode for classroom computer

Input: Draft classroom specification by IT Teacher; Draft security recommendations by CAT Teacher; Draft hardware and software plan by IT Teacher

Output or Expected Output: Recommendation of OS and Browser set up for kiosk mode

What needed to be done and How:

- Research of various available OS and tryout setups (*Proposed by* IT Club, *Driven by* IT Teacher, *Other Drivers:* , *Other Participants:*)

Output or Expected Output: Demo computer

What needed to be done and How:

- Evaluate against requirements & recommend final set up (*Proposed by* IT Club, *Driven by* IT Club members, *Other Drivers:* , *Other Participants:*)
- Installation of selected setup to demo computer (*Proposed by* IT Club, *Driven by* IT Club members, *Other Drivers:* , *Other Participants:*)

Output or Expected Output: Deployment plan

What needed to be done and How:

- Discussion of deployment plan (*Proposed by* IT Teacher, *Driven by* IT Teacher, *Other Drivers:* , *Other Participants:* IT Club members)

Output or Expected Output: Different Kiosk modes to be tested

What needed to be done and How:

- Test with Grade 10 IT students (*Proposed by* IT Club, *Driven by* IT Club, *Other Drivers:* , *Other Participants:* Grade 10 IT Students)

Activity Reference Number: ADM03

Activity Name: Afternoon session to evaluate different Kiosk modes

Attendees: IT club, IT Teacher, Grade 10 IT students

Part of: T-Iteration 4

Tasks: Grade 10 IT students try to break into various kiosk modes set up by the IT Club

Input: Computers set up with different kiosk modes by IT Club

Output or Expected Output: Most secured Kiosk mode

What needed to be done and How:

- Students tried to break out of kiosk mode to run other programs, get on the Internet etc (*Proposed by IT Club, Driven by IT Club, Other Drivers: , Other Participants: Grade 10 IT Students*)

Activity Reference Number: STF14

Activity Name: Notes and MCQ Bot evaluation result discussion; Reminder service evaluation (Mxit & Web)

Attendees: IT Teacher, Physical Science Teacher, Mathematic Teacher

Part of: S-Iteration 2

Tasks: Discussion of results of Mxit Bots evaluation; Discussion of reminder service evaluation (Mxit & Web)

Input: Log Data by MXiT Bots; Students feedback by Subject Teachers; Test results by Subject Teachers

Output or Expected Output: Evaluation of MXiT system at effecting students test result

What needed to be done and How:

- Discussion with teachers involved (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: Students*)
- Summary and Analysis of Results (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: Students*)

Activity Reference Number: STF15A

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 4

Tasks: Finalise specs of classroom computer; Finalise Deployment plan; Finalise Support Plan

Input: Classroom specification by IT Teacher; Demo classroom machine by IT Teacher; Security recommendations by CAT Teacher; Hardware and software plan by IT Teacher; Support Plan by IT Teacher

Output or Expected Output: Final Classroom specs

What needed to be done and How:

- Discussion of plan and issues - update done accordingly (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: IT Club, Other Participants:)*

Output or Expected Output: Final Deployment plan

What needed to be done and How:

- Discussion of plan and issues - update done accordingly (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: IT Club, Other Participants:)*

Output or Expected Output: Final Support plan

What needed to be done and How:

- Discussion of plan and issues - update done accordingly (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: IT Club/Capturers, Other Participants:)*

Output or Expected Output: How to deal with computer illiterate teachers

What needed to be done and How:

- Discussion of issue & recommendation - update done accordingly (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: Capturers, Other Participants:)*

Output or Expected Output: User manual to be produced

What needed to be done and How:

- Produced by capturers with IT teacher's help (*Proposed by IT Teacher, Driven by , Other Drivers: Capturers, Other Participants:)*

Activity Reference Number: STF15B

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 2/3

Tasks: Discussion of results of Mxit Bots evaluation; Discussion of use of web and SMS for delivering message

Input: Summary of results by IT Teacher

Output or Expected Output: Decision on further submedium usage

What needed to be done and How:

- Discussion with teachers involved (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: Modification to EIS to enable these

What needed to be done and How:

- Discussion (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: IT Club, Other Participants:)*
-

Activity Reference Number: STD19

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: T-Iteration 4

Tasks: Deployment Plan; Finalise Image; Image duplication procedure

Input: Classroom specification by IT Teacher; Deployment Plan by IT Teacher; Support Plan by IT Teacher

Output or Expected Output: Deployment Plan Detail

What needed to be done and How:

- Hardware set up detail - Old computers to be cleaned and set up - timeframe commensurate based on trial (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*

Output or Expected Output: Classroom computer image & replication procedure

What needed to be done and How:

- OS & browser modification & update. Installation of selection computer to work out time frame & plan (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*

Output or Expected Output: Hardware support plan

What needed to be done and How:

- Discussion on process. How-to documents & agreement on support (*Proposed by IT Teacher, Driven by IT Club members, Other Drivers: , Other Participants:)*
-

Activity Reference Number: STD20A

Activity Name: IT Club Deployment Sessions (Holidays)

Attendees: IT club, IT Teacher

Part of: T-Iteration 4

Tasks: Set up and deploy classroom computers; Staff account set up on EIS

Input: Deployment Plan by IT Club; Classroom image by IT Club; Staff Information by Admin Staff

Output or Expected Output: Classroom computers installed and tested

What needed to be done and How:

- Students will replicate and set up all computers in lab (*Proposed by IT Club, Driven by , Other Drivers: , Other Participants: IT Club members*)
- Deployment and testing of computers by students to ensure they work as expected (*Proposed by IT Club, Driven by , Other Drivers: , Other Participants: IT Club members*)

Output or Expected Output: Staff Accounts set up

What needed to be done and How:

- Students will set up account except password (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)

Output or Expected Output: Password set up and login slip printed

What needed to be done and How:

- Password changed and slip printed (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants:)*
-

Activity Reference Number: STD20B

Activity Name: IT Club Deployment Sessions (Holidays)

Attendees: IT club, IT Teacher

Part of: S-Iteration 3

Tasks: Link of EIS to MXiT (instead of hardcoded link); Link of EIS to SMS

Input: Example code by SMS Provider

Output or Expected Output: MXiT Linkage done

What needed to be done and How:

- Code PHP link to Java for MXiT bot homework info deliver. IT Teacher work with some member of IT Club (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)

Output or Expected Output: SMS Linkage done

What needed to be done and How:

- Code PHP link to SMS provider gateway. IT Teacher work with some member of IT Club (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)

Activity Reference Number: STD21

Activity Name: Form Capturer/EIS support Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 4

Tasks: Support plan for teachers; Capturing of data for teachers not using EIS; Production of user manual

Input: Support Plan by IT Teacher; Deployment Plan by IT Teacher

Output or Expected Output: Guidelines on providing support to teacher in class

What needed to be done and How:

- Students will discuss issues and agree on what to do - CAT teacher will produce summary (*Proposed by CAT Teacher, Driven by CAT Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: Plan on when capturing will be made

What needed to be done and How:

- Only one capturer needed per day. Schedule draw up by students (*Proposed by Students, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: User manual

What needed to be done and How:

- Students capture screen and produce document (*Proposed by Students, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Activity Reference Number: STF16

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 4

Tasks: Readiness for T-Iteration 4 deployment; Support plan

Input: Deployment Plan by IT Teacher; Deployment Status by IT Teacher; Support Plan by IT Teacher

Output or Expected Output: Final go ahead for Form v3a & EIS

What needed to be done and How:

- Go ahead given based on discussion (*Proposed by Admin Staff, Driven by , Other Drivers: , Other Participants:)*

Output or Expected Output: Suggestions & recommendation

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Admin Staff, Driven by , Other Drivers: , Other Participants:)*

Activity Reference Number: STF17

Activity Name: Web Design Meeting

Attendees: Design Teacher, IT Teacher

Part of: S-Iteration 3

Tasks: Design of EIS Students' front end for web and mobile web

Input: Raw EIS front page for students by EIS

Output or Expected Output: Exercise for students to redesign page

What needed to be done and How:

- Design teacher to set up task for appropriate grade student to work on (*Proposed by Design Teacher, Driven by Design Teacher, Other Drivers: , Other Participants: Design Students*)
 - Input should be gathered from IT club members in the design class (*Proposed by , Driven by , Other Drivers: , Other Participants: IT Club members*)
-

Activity Reference Number: STD22A

Activity Name: IT Club Meeting, IT Teacher

Attendees: IT club

Part of: T-Iteration 4

Tasks: EIS Issues; Evaluation of Hardware support plan

Input: EIS Log and data by EIS; Feedback from students on hardware support by IT Club members

Output or Expected Output: Changes made to EIS, image or procedure

What needed to be done and How:

- Discussion of issues and fix - Students effect changes where possible - IT teacher does others (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*
- Discussion of issues and fix - Changes made to sample computer - reimaging planned for weekends (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*

Output or Expected Output: Summary of issues

What needed to be done and How:

- Summarise by students (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*
-

Activity Reference Number: STD22B

Activity Name: IT Club Meeting, IT Teacher

Attendees: IT club

Part of: S-Iteration 3

Tasks: Discussion of web design project with members who does design

Input:

Output or Expected Output: Discussion with Design teacher

What needed to be done and How:

- Students to ask if Design teacher requires help (*Proposed by Design Teacher, Driven by , Other Drivers: , Other Participants: IT Club members*)
-

Activity Reference Number: STD23

Activity Name: Web Design class exercise

Attendees: Design Teacher, IT Teacher, Design Students

Part of: S-Iteration 3

Tasks: Start of EIS student front end redesign; Sample pages by Design Teacher

Input: Raw EIS front page for students by EIS

Output or Expected Output: Mock up of front pages

What needed to be done and How:

- Students to redesign mock up using photoshop or HTML if familiar (*Proposed by Design Teacher, Driven by Design Teacher, Other Drivers: , Other Participants: Design Students, IT Club Members*)
-

Activity Reference Number: STD24

Activity Name: Form Capturer/EIS support Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 4

Tasks: Evaluation of software support plan
Input: Feedback from students by Capturers
Output or Expected Output: Summary of issues

What needed to be done and How:

- Discussion and summarise by students (*Proposed by CAT Teacher, Driven by Capturers, Other Drivers: , Other Participants:)*

Activity Reference Number: STF18

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 4

Tasks: Evaluation of EIS; Evaluation of support; Usage log by EIS

Input: Feedback from IT Club re hardware and EIS by IT Teacher; Feedback from capturers re software support by IT Teacher

Output or Expected Output: Summary of issues and recommendations

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*
- Discussion (*Proposed by , Driven by , Other Drivers: , Other Participants:)*

Activity Reference Number: STD25A

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: T-Iteration 4

Tasks: EIS Issues; Evaluation of Hardware support plan

Input: EIS Log and data by EIS; Feedback from students on hardware support by IT Club members

Output or Expected Output: Changes made to EIS, image or procedure

What needed to be done and How:

- Discussion of issues and fix. Students effect changes where possible - IT teacher does others (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*
- Discussion of issues and fix. Changes made to sample computer - reimaging planned for weekends (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*

Output or Expected Output: Summary of issues

What needed to be done and How:

- Summarise by students (*Proposed by IT Club, Driven by IT Club members, Other Drivers: , Other Participants:)*

Activity Reference Number: STD25B

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: S-Iteration 3

Tasks: IT Club members account set up on EIS

Input: Student Information by Admin Staff

Output or Expected Output: Accounts set up

What needed to be done and How:

- Students will set up account except password (*Proposed by IT Teacher, Driven by IT Club members, Other Drivers: , Other Participants:)*

Output or Expected Output: Linkage results

What needed to be done and How:

- Club member try out link by accessing homework (*Proposed by IT Teacher, Driven by IT Club members, Other Drivers: , Other Participants:)*

Activity Reference Number: STD26

Activity Name: Web Design Demo

Attendees: Design Teacher, IT Teacher, Design Students

Part of: S-Iteration 3

Tasks: Demo/display of mockup EIS front end; Select suitable interface for implementation

Input: Students mockup/demo by Design Students

Output or Expected Output: Selection of good features selected for implementation

What needed to be done and How:

- Students show off their design and talk about their choice. Students and teachers discuss selection and identify good aspects for implementation. (*Proposed by Design Teacher, Driven by Design Teacher, Other Drivers: , Other Participants: Design Students*)

Output or Expected Output: Combination of features

What needed to be done and How:

- Design teacher works with students to produce single interface combining 'good' features identified earlier (*Proposed by Design Teacher, Driven by Design Teacher, Other Drivers: , Other Participants: Design Students, IT Club members*)

Activity Reference Number: STD27

Activity Name: Form Capturer/EIS support Meeting

Attendees: CAT Teacher, Volunteer Students, IT Teacher

Part of: T-Iteration 4

Tasks: Evaluation of software support plan

Input: Feedback from students by Capturers

Output or Expected Output: Summary of issues

What needed to be done and How:

- Discussion and summarise by students (*Proposed by CAT Teacher, Driven by Capturers, Other Drivers: , Other Participants:)*

Activity Reference Number: STF19A

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 4

Tasks: EIS Issues; Evaluation of Hardware support plan; Formal survey on EIS and support

Input: Feedback from IT Club re hardware and EIS by IT Teacher; Feedback from capturers re software support by IT Teacher; Usage log by EIS

Output or Expected Output: Summary of issues and recommendations

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: Survey to be designed and distributed to teachers

What needed to be done and How:

- Survey form designed and deployed - What needs to be stored discussed and form design teacher will create form based on that (*Proposed by Form Design Teacher, Driven by Form Design Teacher, Other Drivers: , Other Participants:)*

Activity Reference Number: STF19B

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 3

Tasks: Launch plan for students' access to EIS; Students' interface to EIS discussion

Input: Beta test results by IT club by IT Teacher; Front end design mock up by Design Teacher

Output or Expected Output: Launch Plan and date

What needed to be done and How:

- presentation and discussion of results (*Proposed by Deputy, Driven by , Other Drivers: , Other Participants:)*

Output or Expected Output: Feedback to mock up

What needed to be done and How:

- presentation and discussion of mockup (*Proposed by Design Teacher, Driven by , Other Drivers: , Other Participants:)*

Activity Reference Number: STD28

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: S-Iteration 3

Tasks: Student account set up on EIS; Implementation of mockup to web/mobile web front end

Input: Students' timetable Information by Admin Staff; Front end design mock up by Design Students

Output or Expected Output: Accounts set up

What needed to be done and How:

- Students will set up account except password (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)

Output or Expected Output: Password set up and login slip printed

What needed to be done and How:

- IT Teacher add password later and print slip (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: Changes to EIS interface

What needed to be done and How:

- Students effect change where possible - IT teachers helped where necessary (*Proposed by IT Club, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)

Activity Reference Number: STF20A

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: T-Iteration 4

Tasks: EIS Issues Discussion; Evaluation of Hardware support plan

Input: Feedback from IT Club re hardware and EIS by IT Teacher; Feedback from capturers re software support by IT Teacher; Usage log by EIS; Survey Results by Admin Staff

Output or Expected Output: Summary of issues and recommendations

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Activity Reference Number: STF20B

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 3

Tasks: Students' EIS access launch status update; Login info distribution method; EIS Evaluation by students

Input: Account set up result by IT Teacher

Output or Expected Output: Adjustment to plan

What needed to be done and How:

- Discussion (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*

Output or Expected Output: Distribution plan by mentor

What needed to be done and How:

- Mentors will distribute slip to their group of students. Admin staff will package slips for mentor to give out (*Proposed by Deputy, Driven by Admin Staff, Other Drivers: , Other Participants:)*

Output or Expected Output: Students feedback on EIS

What needed to be done and How:

- Mentor will talk about EIS during their normal regular meeting with individual mentee (*Proposed by Grade Head, Driven by Grade Head, Other Drivers: , Other Participants: Mentors*)

Activity Reference Number: STF21

Activity Name: Admin Staff Meeting

Attendees: Admin Staff, IT Teacher, Grade Head

Part of: S-Iteration 3

Tasks: Preparation for student Login Slip Distribution by mentor

Input: Login Slips by IT Teacher

Output or Expected Output: Mentors receive their mentee's login slips

What needed to be done and How:

- Admin staff will package slips for mentor to give out (*Proposed by Deputy, Driven by Admin Staff, Other Drivers: , Other Participants:)*
-

Activity Reference Number: MTM02

Activity Name: Distribution of Login slips

Attendees: Mentors

Part of: S-Iteration 3

Tasks: Student Login Slip Distribution by mentor

Input: Login Slips by Admin Staff

Output or Expected Output: Students receive login slips

What needed to be done and How:

- Mentor give out slips with explanation on how to login and how to get help (*Proposed by Deputy, Driven by Mentors, Other Drivers: , Other Participants: Students*)
-

Activity Reference Number: STF22

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 3

Tasks: Students' EIS deployment update

Input: Log Data by EIS; Mentor Feedback by Grade Heads

Output or Expected Output: Competition to drive up usage rate

What needed to be done and How:

- Modification to EIS to track points (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)

Output or Expected Output: Summary of issues and recommendations

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*
-

Activity Reference Number: MTM03

Activity Name: Mentor meetings - EIS Evaluation

Attendees: Mentors

Part of: S-Iteration 3

Tasks: Mentor discusses any issues with EIS

Input: EIS Usage Data

Output or Expected Output: Feedback on EIS & competition

What needed to be done and How:

- Mentor discuss issues with EIS then summarise for feedback to grade heads (*Proposed by Deputy, Driven by Mentors, Other Drivers: , Other Participants: Students*)
-

Activity Reference Number: STD29

Activity Name: IT Club Meeting, IT Teacher

Attendees: IT club

Part of: S-Iteration 3

Tasks: Adding of point tracking functionality

Input: Competition detail by Planning Team

Output or Expected Output: EIS can now track points

What needed to be done and How:

- Modification of EIS. Code added and a new table created (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)
-

Activity Reference Number: STF23

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 3

Tasks: Students' EIS deployment update;

Input: Log Data by EIS; Mentor Feedback by Grade Heads

Output or Expected Output: Adjustment to competition to introduce referrals

What needed to be done and How:

- Modification to EIS to allow referral (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)

Output or Expected Output: Summary of issues and recommendations

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*
-

Activity Reference Number: STD30

Activity Name: IT Club Meeting

Attendees: IT club, IT Teacher

Part of: S-Iteration 3

Tasks: Adding of more competition functionalities

Input: Competition detail by Planning Team

Output or Expected Output: EIS can now track referrals

What needed to be done and How:

- Modification of EIS (*Proposed by IT Teacher, Driven by IT Teacher, Other Drivers: , Other Participants: IT Club members*)
-

Activity Reference Number: STF24

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 3

Tasks: Students' EIS deployment update

Input: Log Data by EIS; Mentor Feedback by Grade Heads

Output or Expected Output: Extension of evaluation period

What needed to be done and How:

- Discussion (*Proposed by IT Teacher, Driven by , Other Drivers: , Other Participants: IT Club members*)

Output or Expected Output: Summary of issues and recommendations

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*
-

Activity Reference Number: STF25

Activity Name: Planning Team Meeting

Attendees: Planning Team

Part of: S-Iteration 3

Tasks: Students' EIS deployment conclusion

Input: Log Data by EIS; Mentor Feedback by Grade Heads

Output or Expected Output: Summary of issues and recommendations

What needed to be done and How:

- Any issue raised at meeting - summarised for changes (*Proposed by Deputy, Driven by IT Teacher, Other Drivers: , Other Participants:)*
-

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Bibliography

- Western Cape Department of Education (WCED). (2011). *General Information on Western Cape Department of Education's Khanya Project*. Retrieved 12 5, 2011, from Western Cape Department of Education's Khanya Project: <http://www.khanya.co.za/projectinfo/?catid=32>
- Scottish Famous Firsts: James Pillans*. (2008). Retrieved Jan 6, 2011, from Gazetteer for Scotland: <http://www.scottish-places.info/people/famousfirst281.html>
- Adendorff, M., Mason, M., Modiba, M., Faragher, L., & Kunene, Z. (2002). *Being a Teacher: Professional Challenges and Choices*. (J. Gultig, Ed.) South African Institute of Distance Education (SAIDE).
- Atkinson, R. (1968, Apr). Computerized Instruction and the Learning Process. *American Psychologist*, 23(4), 225-239.
- Attwell, P. (2006, Jan 17). Western Cape Ready for FET Curriculum in Schools. *Cape Gateway*.
- Babbie, E., & Mouton, J. (2001). *The Practice of Social Research*. Oxford University Press.
- Bladergroen, M., Chigona, W., Bytheway, A., Cox, S., Dumas, C., & van Zyl, I. (2012). Educator discourses on ICT in education: A critical analysis. *International Journal of Education and Development using Information and Communication Technology*, 8(2), 107-119.
- Blomberg, J., Giacomi, J., Mosher, A., & Swenton-Wall, P. (1993). Ethnographic Field Methods and Their Relation to Design. In D. Schuler, & A. Namioka (Eds.), *Participatory Design: Principles and Practices*. Lawrence Erlbaum Associates, Inc.
- Bond, R., & Hulme, D. (1999). Process Approaches to Development: Theory and Sri Lankan Practice. *World Development*, 27(8), 1339-1358.
- Bransford, J. (2000). *How people learn: brain, mind, experience, and school*. National Research Council (US).

Bibliography

- Brown, H. (2003). The role of m-learning in the future of elearning in Africa. *ICDE World Conference*.
- Bumstead, J. F. (1841). *The black board in the primary school*. Boston, Perkins & Marvin.
- Carnoy, M. (1975). The Economic Costs and Returns to Educational Television. In M. Carnoy, *Economic Development and Cultural Change*.
- Cellular.co.za. (n.d.). *Statistics of Cellular Usage in South Africa*. Retrieved Nov 15, 2007, from http://www.cellular.co.za/stats/statistics_south_africa.htm
- Chigona, A., Chigona, W., Kausa, M., & Kayongo, P. (2010). An Empirical Survey on Domestication of ICT in Schools in Disadvantaged Communities in South Africa. *International Journal of Education and Development Using ICT*, 6(2), 21-32.
- Danesh, A., Inkpen, K., Lau, F., Shu, K., & Booth, K. (2001). Geney: Designing a Collaborative Activity for the Palm Handheld Computer. *CHI* (pp. 388-395). New York, NY: ACM.
- Davis, S. (2002). Research to Industry: Four Years of Observations in Classrooms using a Network of Handheld Devices,. *Proceedings. IEEE International Workshop on Wireless and Mobile Technologies in Education* (pp. 31- 38). IEEE.
- Eighty20. (2004). South African AMPS 2004 Household Survey. Cape Town, South Africa: Eighty20.
- Eighty20. (2010). South African AMPS 2010 Household Survey. Cape Town, South Africa: Eighty20.
- Ergo in Demand. (2006). *About Blackboards - Blackboard Technology and Chalkboard History Advance*. Retrieved Dec 16, 2010, from Ergo in Demand: http://www.ergoindemand.com/about_chalkboards.htm
- Febvre, L., & Martin, H.-J. (1976). *The Coming of the Book*. (G. Nowell-Smith, & D. Wootton, Eds.) Verso.
- Frias-Martinez, V., Virseda, J., & Gomero, A. (2012). Mobilizing education: Evaluation of a Mobile Learning Tool in a Low-income School. *Proceedings of*

- the 14th international conference on Human-computer interaction with mobile devices and services*, (pp. 441-450). San Francisco.
- Gadebe, T. (2005, Aug 22). New curriculum focuses on Africa. *South Africa.info*.
- Heeks, R. (2002). Information Systems and Developing Countries: Failure, Success and Local Improvisations. 101-112.
- Heeks, R., & Molla, A. (2009). Impact Assessment of ICT-for-Development Projects: A Compendium of Approaches. In *Development Informatics Working Papers*. University of Manchester.
- Hesse-Biber, S., & Leavy, P. (2010). *The Practice of Qualitative Research* (2nd Edition ed.). Sage.
- Ho, S., & Ho, K. (2011). Mobile Messages as a Tool to Stimulate Learning Activities. *Proceedings of the Thirteenth Australasian Computing Education Conference*, 114, pp. 3-8. Perth, Australia.
- Huges, N., & Lonie, S. (2007, August). M-PESA: Mobile Money for the "Unbanked". *Innovations: Technology, Governance, Globalization*, 63-81.
- Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B., Druin, A., Plaisant, C., & M Beaudouin-Lafon, S. C. (2003). Technology Probes: Inspiring Design for and with Families. *Proceedings of the SIGCHI conference on Human factors in computing systems*. CHI.
- Independent Online. (2006, Sep 17). *News Article - Sex forces school cellphone ban*. Retrieved Dec 23, 2010, from Independent Online: <http://www.iol.co.za/news/south-africa/sex-forces-school-cellphone-ban-1.293956>
- Kam, M., Kumar, A., Jain, S., Mathur, A., & Canny, J. (2009). Improving literacy in rural India: Cellphone games in an afterschool program. In *Proc. of IEEE/ACM Conference*.
- Kgosana, C. (2006, Jan 8). Chaos looms as schools launch new curriculum. *City Press*, 1. City Press.

Bibliography

- Khanya Project - WCED. (2008). *Khanya Annual Report for the Period March 2007 to April 2008*.
- Knight-John, M. (2008). Making a Business out of a Village Phone. In R. Samarajiva, & A. Zainudeen (Eds.), *ICT Infrastructure in Emerging Asia: Policy and Regulatory Roadblocks* (pp. 116-130). New Delhi: SAGE Publications.
- Legard, R., Keegan J, & Ward K. (2003). In-depth interviews. In R. J, & L. J (Eds.), *Qualitative research practice: a guide for social science students and researchers* (pp. 129-169). SAGE.
- Marsden, G. (2003). Using HCI to leverage communication technology. *Interactions*, 10(2), pp. 48-55.
- Mcluhan, M. (1962). *The Gutenberg Galaxy*. University of Toronto Press.
- Mhlongo, A. (2006, Jan 31). Teachers not ready to teach new curriculum. *Independent Online*. Independent Online.
- Moher, T., Ding, X., Wiley, J., Conmy, D., Hussain, S., Singh, P., & Srinivasan, V. (2003). Combining Handhelds with a Whole-Class display to Support the Learning of Scientific Control. *Extended Abstract of CHI* (pp. 882-883). ACM.
- Moodle. (n.d.). Retrieved Dec 22, 2010, from Moodle: <http://www.moodle.org>
- MXit. (n.d.). MXit. Retrieved Jan 15, 2011, from MXit Mobile Chat: <http://www.mxit.co.za>
- NationMaster. (2005). *Worldwide statistics of pupils-teacher ratio at secondary education level*. Retrieved Oct 22, 2005, from http://www.nationmaster.com/graph-T/edu_pup_tea_rat_sec_lev
- Nkosi, B. (2012, 12 21). Spectre of Inspectors Irks Teacher Unions. *Mail and Guardian*. Johannesburg, Gauteng, South Africa.
- Nthite, T., & Otto, H. (2005, Nov 22). Pandor upbeat ahead of new curriculum launch. *Independent Online*. Independent Online.
- Parliamentary Monitoring Group. (2010, Aug 17). *Quality of Education and Challenges thereto: Considerations of Submissions received during Public Hearings Day 2*.

Bibliography

- Retrieved Aug 28, 2010, from Parliamentary Monitoring Group:
<http://www.pmg.org.za/report/20100817-consideration-submissions-received-during-public-hearings>
- Presence, C. (2010, 11 19). *Grant beneficiaries spend money on airtime*. (L. Mlandu, Editor) Retrieved 12 22, 2010, from Eye Witness News (EWN):
<http://www.eyewitnessnews.co.za/articleprog.aspx?id=53235>
- Reiser, R. A. (1987). *Instructional Technology: A History*. In R. A. Reiser, & R. M. Gagne (Ed.), *Instructional Technology: Foundations*. Lawrence Erlbaum Associates.
- Roodt, J., & Conradie, P. (2003). Creating a learning culture in rural schools via educational satellite TV broadcasts. *Globalisation, Regionalisation and the Information Society*.
- Scipio, J. (2005). *The Khanya Methodology for ICT Implementation in Schools*. Cape Town: WCED.
- Scottish Famous Firsts: James Pillans*. (n.d.). Retrieved Jan 6, 2011, from Gazetteer for Scotland: <http://www.scottish-places.info/people/famousfirst281.html>
- Seale, L. (2006, Jan 11). Schools raise concerns about new curriculum. *The Star*. The Star.
- Senne, D. (2006, Jan 25). SA operators top 44m mobile subscribers. *ITWeb*.
- Sikhakhane, J. (2006, May 16). Cellular subscriber numbers could do with some auditing. *Business Report*.
- South African Department of Education. (1996). *Lifelong Learning through a National Curriculum Framework*. South African Department of Education.
- South African Department of Education. (2000). *A South African curriculum for the twenty first century: report of the Review Committee on Curriculum 2005*.
- South African Department of Education. (2001). Education White Paper 6 on Special Needs Education: Building an Inclusive Education and Training System.

Bibliography

- South African Department of Education. (2001, July). The National Policy on Whole-School Evaluation. Pretoria, South Africa.
- South African Department of Education. (2002). *Curriculum 2005 Assessment Guidelines for Inclusion*. South African Department of Education.
- South African Department of Education. (2002). *Revised National Curriculum Statement Grades R-9 (Schools)*. South African Department of Education.
- South African Department of Education. (2003). National Curriculum Statement Grade 10-12 (General) Overview.
- South African Department of Education. (2005). Rights and Responsibilities of Parents, Learners and Public Schools.
- South African Department of Higher Education and Training. (2008). *National Qualifications Framework Act 67 of 2008: Policy on the Minimum Requirements for Teacher Education Qualification*. Pretoria.
- South African Government Department of Communication and Information System. (2009). *Pocket Guide to South Africa 2009/10* (7th Edition ed.). (D. Burger, Ed.)
- South African Government White Paper. (1998). *Programme for the Transformation of Further Education and Training: Education White Paper*. Retrieved Nov 15, 2007, from South African Government White Papers: <http://www.info.gov.za/whitepapers/1998/19281.pdf>
- South African Government White Paper. (2004). *White Paper on e-Education: Transforming learning and teaching through information and communication technologies*. Retrieved Oct 15, 2005, from South African Government White Papers: <http://www.info.gov.za/gazette/whitepaper/2004/26734.pdf>
- South African Government White Paper. (2004). *White Paper on e-Education: Transforming learning and teaching through information and communication technologies*. Retrieved Oct 15, 2005, from South African Government White Papers: <http://www.info.gov.za/gazette/whitepaper/2004/26734.pdf>
- South African Police Service. (2006). *South African Police Service (SAPS) annual report 2004/2005*. Retrieved Nov 15, 2007, from South African Police Service:

http://www.saps.gov.za/saps_profile/strategic_framework/annual_report/index.htm

Statistics South Africa. (2004, July). *General Household Survey*. Retrieved Nov 15, 2007, from Statistics South Africa: <http://www.statssa.gov.za/publications/P0318/P0318July2004.pdf>

Surry, D. W. (1997). Diffusion Theory and Instructional Technology. *Annual Conference of the Association for Educational Communications and Technology (AECT)*. Albuquerque, New Mexico.

Tacchi, J., Slater, D., & Hearn, G. (2003). *Ethnographic Action Research*. United Nations Educational.

Tyler, I. (1960, Oct 12). Television Frees the Teacher. *Educational Research Bulletin*, 39(7), 169-178.

Unesco. (2002). *Information and Communication Technology in Education. A Curriculum for Schools and Programme of Teacher Development*.

United Nations. (2000). *United Nations Millennium Development Goals - Goal 8: Developing a Global Partnership for Development*. Retrieved from United Nations Millennium Development Goals: <http://www.un.org/millenniumgoals/global.shtml>

United Nations Office on Drugs and Crime, Centre for International Crime Prevention. (n.d.). *Seventh United Nations Survey of Crime Trends and Operations of Criminal Justice Systems, covering the period 1998 - 2000*. Centre for International Crime Prevention, United Nations Office on Drugs and Crime. UN.

Walton, M., & Heeks, R. (2011). Can a Process Approach Improve ICT4D Project Success? In *Development Informatics Working Papers*. University of Manchester.

Wang, M., Shen, R., Tong, R., Yang, F., & Han, P. (2005). Mobile learning with cellphones and PocketPCs. *ICWL 2005*. Springer-Verlag, Berlin Heidelberg.

Wesch, M. (2007, Oct 12). *A Vision of Students Today*. Retrieved May 25, 2008, from YouTube: <http://www.youtube.com/watch?v=dGCJ46vyR9o>

Bibliography

Western Cape Education Department. (2010, 01 07). *2009 Western Cape NSC Examination Results*. Retrieved 12 22, 2010, from Western Cape Education Department (WCED): <http://wcedmis.wcape.gov.za/wcedmis/webpub2.examresults.home>

Wilson-Strydom, M., & Thomson, J. (2005). *Understanding ICT integration in South African Classrooms*. SchoolNet South Africa. SchoolNet South Africa.

Woods, P. (1996). *Researching the Art of Teaching: Ethnography for Educational Use*. London: Routledge.

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